Environmental Assessment For Supersonic Flight Over The Nellis Range Complex

Nellis Air Force Base
Las Vegas, Nevada

United States Air Force

FINDING OF NO SIGNIFICANT IMPACT

1.0 NAME OF ACTION: Continuation of Supersonic Flight Operations over the Nellis Range Complex

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES: The U.S. Air Force proposes to continue supersonic flights below 30,000 feet mean sea level (MSL) over Nellis Range Complex. Approximately 65,000 annual sorties are flown over the complex per year, with an average of 10 percent involving supersonic flight activity. Air Combat Command (ACC) has a continuing need for large blocks of airspace near Nellis Air Force Base which meet the criteria (e.g., airspace size and distance from the base) for airspace used in the training of flight crews, including training at supersonic speed below 30,000 feet MSL. The proposed action will not change the number, frequency, or duration of supersonic flight operations, but rather continue the current level of activity. Two alternatives, in addition to the proposed action, were identified and evaluated: 1) Use Another Special-Use Airspace and 2) the No Action Alternative.

3.0 SUMMARY OF ENVIRONMENTAL EFFECTS: Based on the analysis, the potential impacts to the natural and man-made environment from the continuation of supersonic flights over the Nellis Range Complex would not be significant. The following examines the environmental consequences of the proposed action on a resource by resource basis.

Land Use: The proposed action would not change or alter the land use in the Nellis Range Complex. Existing land use in the area is compatible with military aircraft training and supersonic flight operations. No impact to the land use or people living and working below the airspace would, therefore, result from the proposed action.

Air Quality: The proposed action would continue supersonic flight operations as currently conducted, therefore, emissions would remain at current levels. Emissions would continue to be spread over the entire 20,710 square miles of the Nellis Range Complex and the impacts from aircraft sorties would be insignificant. The proposed action, a continuing and recurring activity, would be in conformity with the State Implementation Plan and would be exempt from the requirements to prepare a conformity determination.

Noise: The proposed action would not increase or decrease the level of noise or the number of sonic booms within the Nellis Range Complex. The average sonic boom overpressure would remain just under one pound per square foot; a small percentage of booms, 1.3 percent, would have an amplitude in excess of five pounds per square foot. The maximum noise levels for sonic booms, or the ongoing subsonic activity, fall in the human annoyance range of less than 10 percent of the population. Therefore, impacts to the limited population exposed in the Nellis Range Complex are negligible. Additionally, due to the low intensity of the average boom, it is expected that significant structural damage, glass or otherwise, would not occur. With respect to the effects of sonic booms on wild and domestic animals, recent physiological and behavioral studies of mammals on USAF ranges have suggested that animals tend to habituate to sonic booms and long-terms effects are not adverse. Although studies are still in progress, it appears that the sonic boom environment on the Nellis Range Complex, which is not hostile to humans, is also not hostile to animals. Overall, continuation of supersonic operations will not result in significant noise impacts to humans, animals, or structures.

Biological Resources: The proposed action would not have an impact on the vegetation or wildlife habitat since the proposed action does not involve ground-based activity. Threatened and endangered species or other wildlife or domestic animals, potentially occurring within the Nellis Range Complex, would not be significantly affected by the continuation of supersonic operations.

Cultural Resources: Supersonic flights within the Nellis Range Complex would pass over areas with hundreds of historic properties in the form of archeological sites, aboveground rock structures, rock art, and structures related to historic settlement at altitude. The potential for noise-induced damage to historic properties is not well documented; however, studies indicate historic structures may be less sensitive than popularly thought. Studies indicate that sonic boom overpressures of less than five pounds per square foot would result in particle velocities within the safe range for historic structures. There has been no indication that past activity has caused detrimental effects in the Nellis Range Complex, thus with the flight operations remaining unchanged, there should be no change to historic properties.

Implementation of the proposed action would require the continued commitment of irretrievable and irreversible resources. These resources would include tax dollars, fuel, electrical energy, manpower, equipment, support materials and supplies. The continuance of supersonic flight operations would not sacrifice the maintenance and enhancement of the long-term productivity of the environment for the short-term use of the Nellis Range Complex.

4.0 CONCLUSIONS

Based on the findings of the environmental analysis, the proposed action would not result in any significant impacts to the natural or man-made environment. A Finding of No Significant Impact is thus warranted.

STONEY P. CHISOLM
Colonel, USAF
Chairperson, Environmental Leadership Board

Date 25 Sept '94

EXECUTIVE SUMMARY

1.0 Description of Proposed Action

The U.S. Air Force proposes to continue supersonic flights over the Nellis Range Complex.

2.0 Purpose and Need

The U.S. Air Force Air Combat Command has a continuing need for large blocks of airspace near Nellis Air Force Base which meet the criteria (e.g., airspace size and distance from the base) for airspace used in the training of flight crews at supersonic speeds below Flight Level 300 (i.e., below 30,000 feet above mean sea level).

3.0 Alternatives to the Proposed Action

Two alternatives to the proposed action were identified and evaluated in this environmental assessment:

- No action, and
- Use another special-use airspace for training Nellis aircrews.

Under the no action alternative, supersonic flights below Flight Level 300 within the Nellis Range Complex would cease. Supersonic training below Flight Level 300 for all Department of Defense services at the Nellis Range Complex would also cease. This would result in aircrews not receiving adequate low level flight training regarding the full operational capabilities of the aircraft.

For the "use another special-use airspace" alternative, other distant special-use areas were considered for use by aircrews from Nellis Air Force Base. The closest supersonic airspaces are in southern Arizona, southern California, and over the Pacific Ocean off the southern California coast. This alternative would not meet the criteria of having supersonic airspace in close proximity to Nellis Air Force Base or have scheduling-and-use priority in the other supersonic airspace. The increased distance to the other special-use airspaces would also decrease time on station, increase aircraft fuel consumption, and may require air-refueling support. Supersonic training requirements for Nellis aircrews would not be adequately or economically fulfilled, and as a result this alternative was not carried forward for further analysis.

4.0 Analysis of Environmental Impacts

Land use below the supersonic airspace would not be changed and therefore would not be impacted. Wildlife and domestic animals, based on recently completed studies, would not be impacted. Local wildlife and domestic animals have acquired acclimation/habituation to sonic booms. However, some migratory animals would potentially experience short-term startle from the sonic booms. Future noise levels would be similar to existing levels since the same types of aircraft and the same relative number and duration of supersonic flights would occur, so no direct effect on wildlife or domestic animals would occur. Residents living and working below the Nellis Range Complex airspace would not be significantly affected since they would not be exposed to increases in noise levels. Air quality would not be degraded based on the types of aircraft flown, number of sorties, hours of flight, and existing air quality. The proposed action, in general, would not adversely impact known cultural resources. Since the noise study of sonic booms related to F-15, F-16, and F-18 aircraft indicated that only three percent of the sonic boom overpressures exceeded the safe range for historic structures, the potential impact to historic properties would be negligible.

Based on the analysis of the environmental impacts, the potential impacts to the natural and man-made environment from the continuation of supersonic flights within the Nellis Range Complex would not be significant.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACC	=	Air Combat Command
ACM	=	air combat maneuvers
ACMI	=	Air Combat Maneuver Instrumentation
AFB	=	Air Force Base
AFR	=	Air Force Regulation
AGL	=	above ground level
BEAR	=	boom event analyzer recorder
BFM	=	basic fighter maneuvers
BLM	=	Bureau of Land Management
CAA	=	Clean Air Act
CE	=	critically endangered
CEQ	=	Council on Environmental Quality
CFR	=	Code of Federal Regulations
CO	=	carbon monoxide
CSEL	=	C-weighted sound exposure level
DACT	=	dissimilar aircraft combat training
dB	=	decibel
dBA	=	A-weighted decibel
dBC	=	C-weighted decibel
DNWR	=	Desert National Wildlife Refuge
DOD	=	Department of Defense
DOE	=	Department of Energy
E	=	endangered
EA	=	Environmental Assessment
e.g.	=	exempli gratia (for example)
EIS	=	Environmental Impact Statement
EPA	=	Environmental Protection Agency
ESA	=	Endangered Species Act
et al.	=	et alii (and others)
et seq.	=	et sequens (and the following)
F	=	Fahrenheit
FAA	=	Federal Aviation Administration
FG	=	Fighter Group
FL	=	flight level
FONSI	=	Finding of No Significant Impact
FSS	=	Flight Service Station
HC	=	hydrocarbons
Hz	=	hertz
i.e.	=	id est (that is)
IFR	=	instrument flight rules
IPCT	=	instructor pilot continuation training
IR	=	instrument route
LATN	=	low altitude tactical navigation
L_{Cdn}	=	day-night average C-weighted sound level
L_{dn}	=	day-night average sound level

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

L_{pk}	=	sound level corresponding to the peak overpressure
mg/l	=	milligrams per liter
MOA	=	Military Operations Area
MSL	=	mean sea level
MTR	=	Military Training Route
NAAQS	=	National Ambient Air Quality Standards
NATCF	=	Nellis Air Traffic Control Facility
NEPA	=	National Environmental Policy Act
NM	=	nautical miles
NO_2	=	nitrogen dioxide
NO_x	=	nitrogen oxides
NOAA	=	National Oceanic and Atmospheric Administration
NOTAM	=	Notice to Airmen
NRA	=	National Recreation Area
NSA	=	Noise Sensitive Areas
NWR	=	National Wildlife Refuge
O_3	=	ozone
P	=	protected
Pb	=	lead
PL	=	Public Law
PM_{10}	=	particulate matter less than 10 microns in diameter
ppm	=	parts per million
PSD	=	Prevention of Significant Deterioration
psf	=	pounds per square foot
R	=	Restricted Area
RFMDS	=	Red Flag Mission Debriefing System
S	=	sensitive
SAIC	=	Science Applications International Corporation
SEL	=	sound exposure level
SIP	=	State Implementation Plan
SO_2	=	sulfur dioxide
spp.	=	species
ssp.	=	subspecies
T	=	threatened
TPEC	=	Tolicha Peak Electronic Combat
TSS	=	total suspended solids
$\mu g/m^3$	=	micrograms per cubic meter
USAF	=	U.S. Air Force
USAFWTC	=	U.S. Air Force Weapons Training Center
USDA	=	U.S. Department of Agriculture
USDOI	=	U.S. Department of Interior
USFWS	=	U.S. Fish and Wildlife Service
var.	=	variety
VFR	=	Visual Flight Rules
VOC	=	volatile organic compounds

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

VR	=	visual route
WMA	=	Wildlife Management Area
WRA	=	Wildlife Resource Area
WSA	=	Wilderness Study Area
WWF	=	World Wildlife Fund

1.0 PURPOSE AND NEED FOR THE ACTION

1.1 The Proposed Action

The U.S. Air Force (USAF) proposes the continuance of supersonic flight operations below Flight Level (FL) 300 (i.e., below 30,000 feet mean sea level [MSL]) over the Nellis Range Complex (Figure 1-1).

1.2 Need

The USAF Air Combat Command (ACC) has a continuing need to use large blocks of airspace near Nellis Air Force Base (AFB) for the training of aircrews in tactical maneuvers at supersonic speeds. The aircrew training at both subsonic and supersonic speeds is necessary in order to enable the aircrews to function well in all possible situations. Airspace close to the base where the aircrews are stationed is desirable in order to minimize transit distance and maximize actual training time. Modern aircraft do not have adequate fuel capacity to allow them to fly long distances to reach available airspace and still conduct an adequate amount of flight training, including that at supersonic speeds. In addition, virtually all currently available airspace is needed and utilized extensively to conduct the levels of aircrew training needed to sustain the USAF's mission.

1.3 Objective of the Proposed Action

The mission of Nellis AFB is to organize, train, and equip tactical air squadrons for operational deployment in support of national defense and to meet international commitments. Past combat experience has demonstrated that the effectiveness and survival of aircrews exposed to sophisticated aircraft and advanced anti-aircraft weapons systems are directly affected by the type, quality, and amount of training they receive. Acquiring proficient aerial combat skills requires extensive training. Once these skills are acquired, aircrews must continue aerial combat training to maintain proficiency. The Nellis Range Complex not only contains the airspace needed to train aircrews in supersonic flight, but sufficient airspace is available to ensure operation within the full envelope of the aircraft's capabilities for realistic and frequent training experiences at supersonic speeds below FL 300.

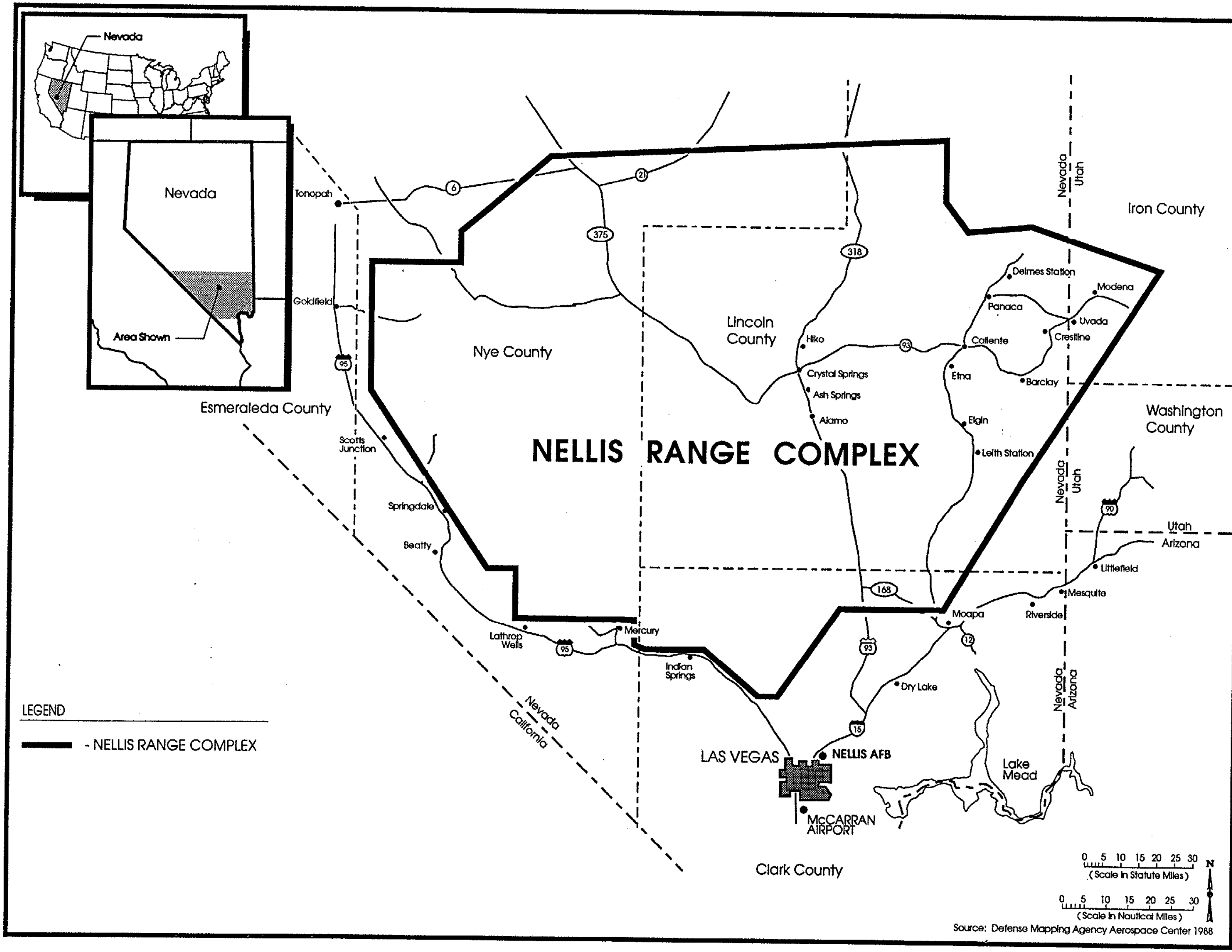


Figure 1-1. Nellis Range Complex Location Map .

1.4 USAF Supersonic Policy

The USAF policy is to conduct supersonic flight operations wherever possible over open water areas at altitudes above 10,000 feet MSL. Supersonic flight over land is normally conducted above FL 300 (i.e., above 30,000 feet MSL).

Under AFR 55-34, revised July 1990, the waiver to conduct supersonic flight below FL 300 must be reviewed and renewed every three years. The request for renewal of an existing waiver for supersonic flights is submitted to ACC for approval. The request for waiver renewal must include a review of past aircraft operations, an analysis of any effects of the supersonic flights, and a detailed review of future aircraft operations.

1.5 Decision to be Made

The decision to be made by ACC is whether or not to implement the proposed action and continue supersonic flights below FL 300 over the Nellis Range Complex. If appropriate, a waiver would be issued for future supersonic flights in accordance with AFR 55-34.

1.6 Relevant Environmental Issues

The relevant environmental resources that would potentially be affected by the proposed action include land use; biological resources including threatened and endangered species; air quality; noise; and archeological, cultural, and historical properties. The proposed action would not impact climate, geology, soils, water resources, socioeconomic conditions, or the transportation system within the area of the proposed action.

1.7 Environmental Regulatory Review

Under the National Environmental Policy Act (NEPA) (Public Law [P.L.] 91-190, 42 United States Code 4321 et seq.) as amended in 1975 by P.L. 94-83 and P.L. 95-52, federal agencies are required to consider the environmental consequences of proposed actions in the decision-making process. The intent of NEPA is to protect, restore, and enhance the environment through well informed federal decisions.

The Council on Environmental Quality (CEQ) was established under Title II of NEPA to implement and oversee federal policy in this process. To this end, CEQ has issued *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 Code of Federal Regulations [CFR] Part 1500-1508, 1978). The CEQ regulations specify that an environmental assessment (EA) serves to:

- Briefly provide evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or issue a Finding of No Significant Impact (FONSI) (40 CFR 1508.9);
- Aid in agency compliance with NEPA when an EIS is unnecessary; and
- Facilitate preparation of an EIS when one is necessary.

To comply with NEPA and to assess impacts on the environment, the decision-making process for the proposed action includes a study of relevant environmental issues. This EA has been prepared to evaluate potential environmental impacts resulting from continued supersonic flight below FL 300 in the Nellis Range Complex near Nellis AFB, Nevada. This document was prepared in accordance with AFR 19-2 (Environmental Impact Analysis Process, 32 CFR 989) which implements Section 102 of NEPA and the regulations established by the President's CEQ (40 CFR 1500-1508).

1.8 Regulatory Compliance

In addition to NEPA, other federal acts and regulations may be applicable to the proposed continuation of supersonic flight training at Nellis Range Complex. Relevant federal legislation is listed in Table 1-1.

Table 1-1

Major Environmental Laws Applicable to the Proposed Action

Environmental Parameter	Federal Regulation
Air	Clean Air Act (CAA) of 1970 and Amendments of 1977 (P.L. 95-95) and 1990 (P.L. 91-604)
Noise	Noise Control Act of 1972 (P.L. 92-574) and Amendments of 1978 (P.L. 95-609)
Land	Wilderness Act of 1964 (P.L. 88-577) National Forest Management Act (NFMA) of 1976 (P.L. 94-588) Federal Land Policy and Management Act (FLPMA) of 1976 (P.L. 94-579) Public Rangelands Improvement Act of 1978 Farmland Protection Policy Act of 1981 (P.L. 97-98)
Fish and Wildlife Resources	Migratory Bird Treaty Act of 1918 Bald Eagle Protection Act of 1940 Fish and Wildlife Coordination Act of 1958 (P.L. 85-654) Sikes Act of 1960 (P.L. 86-797) Endangered Species Act (ESA) of 1973 (P.L. 93-205) and the Amendments of 1988 (P.L. 100-478) Fish and Wildlife Conservation Act of 1980 (P.L. 96-366)
Cultural/Native American Resources	National Historic Preservation Act (NHPA) of 1966 (P.L. 89-665) and Amendments of 1980 (P.L. 96-515) Executive Order 11593, Protection and Enhancement of the Cultural Environment-1971 Archeological and Historic Preservation Act (AHPA) of 1974 (P.L. 93-291) American Indian Religious Freedom Act (AIRFA) of 1978 (P.L. 95-341) Archeological Resources Protection Act (ARPA) of 1979 (P.L. 96-95) Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (P.L. 101-601)
Wetlands	Executive Order 11990, Protection of Wetlands-1977 Emergency Wetlands Resources Act (EWRA) of 1986 (P.L. 99-645) North American Wetlands Conservation Act of 1989 (P.L. 101-233)

Source: USFWS 1992a

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 The Proposed Action

The USAF proposes the continuance of supersonic flight operations below FL 300 over the Nellis Range Complex.

2.1.1 Description of the Nellis Range Complex

The Nellis Range Complex encompasses an area of approximately 20,700 square miles (13.2 million acres). The complex is composed of both land and airspace components. The airspace components (Figure 2-1) include the Reveille and Desert Military Operations Areas (MOAs) and six (6) restricted areas. Desert MOA is divided into five subdivisions: Coyote, Caliente, Cedar, Elgin, and Sally Corridor. The restricted areas include: R-4806 E & W, R-4807 A & B, R-4808 N & S, and R-4809. Restricted areas R-4806 E & W, R-4807 A & B, and R-4809 are controlled by the USAF, while R-4808 N & S is controlled by the Department of Energy (DOE). The ground components (Figure 2-2) of the Nellis Range Complex underlie the restricted airspace and include a number of ranges used for air-to-ground gunnery and weapons delivery. Users of the Nellis Range Complex include the Army, Navy, Marine Corps, Air National Guard, and Air Force Reserve.

2.1.2 Nellis Range Complex Operations

A combination of USAF regulations and Federal Aviation Administration (FAA) rules and regulations govern the use of the Nellis Range Complex airspace. The Nellis Range Complex airspace is managed by the Nellis Air Traffic Control Facility (NATCF) by letter of agreement with the Los Angeles Air Traffic Control Center. Airspace access is obtained by contacting NATCF at Nellis AFB. Civilian aircraft may travel through a restricted airspace only after receiving permission from NATCF. All civilian and non-participating military aircraft are generally prohibited from flying through restricted airspace during military training exercises. Prior to entering a MOA, the pilot of a civilian aircraft typically would contact the NATCF, the nearest flight service station (FSS), or an air traffic control facility to obtain the current notice to airman (NOTAM) on military aircraft activity within the MOAs.

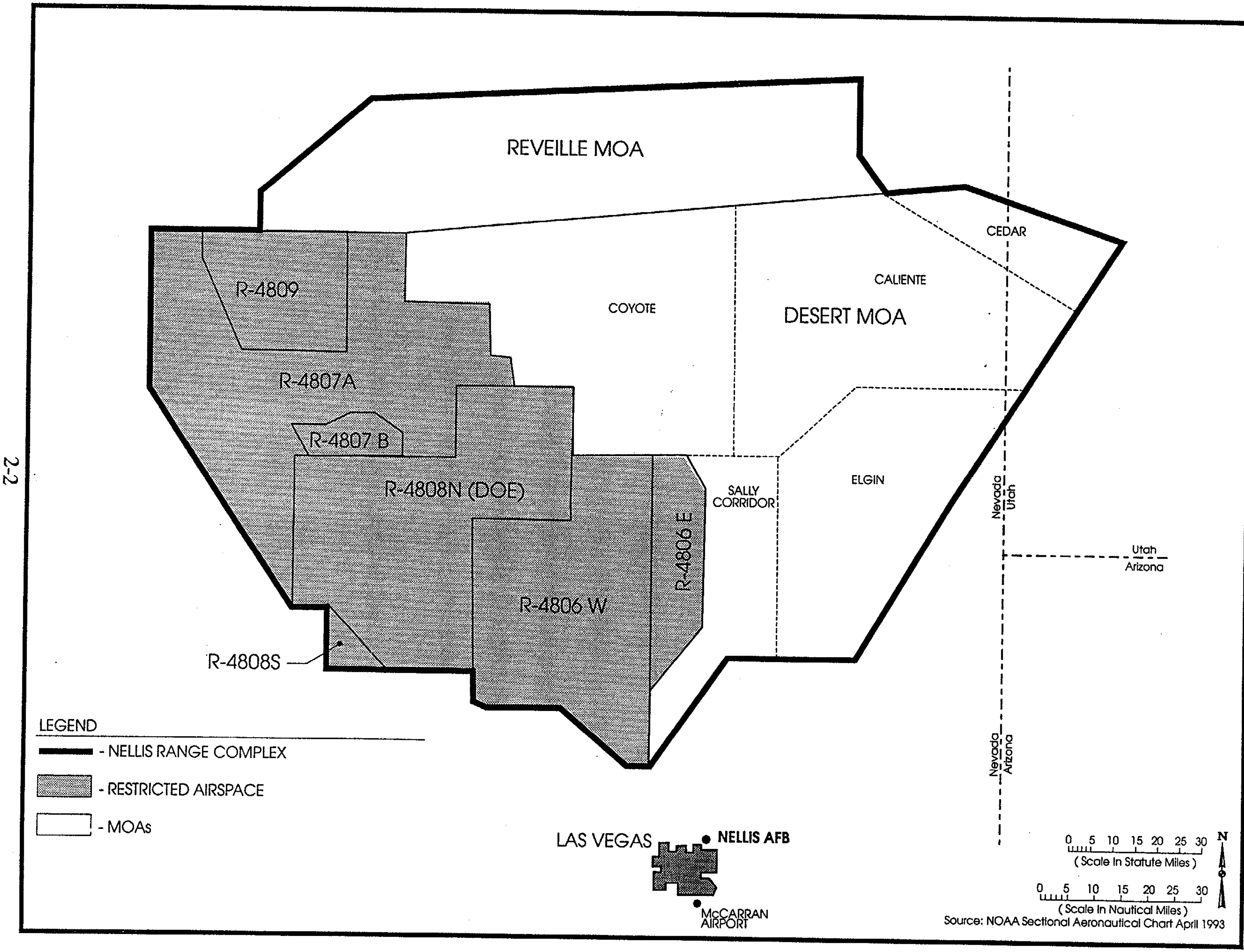


Figure 2-1. Nellis Range Complex Airspace Areas.

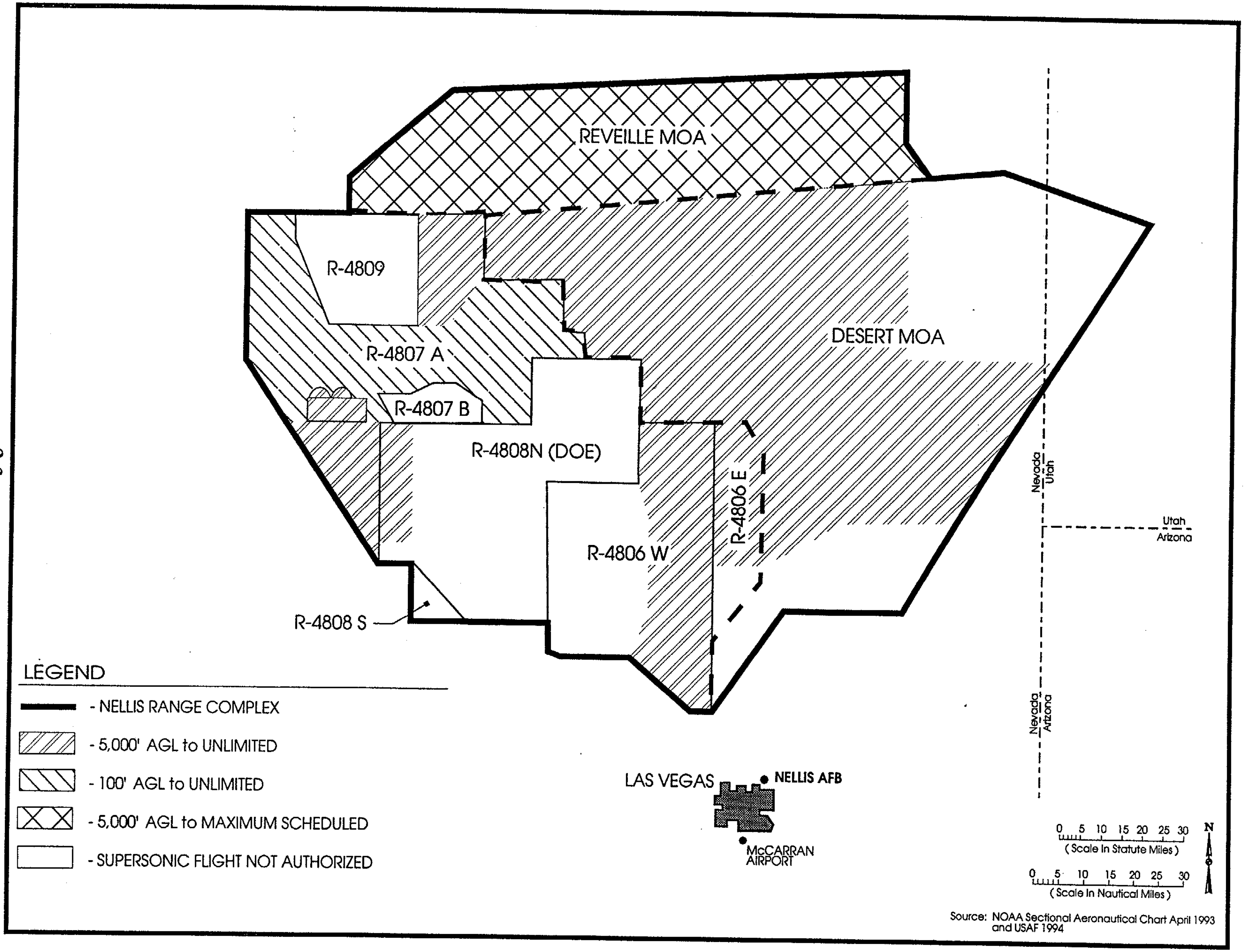


Figure 2-3. Nellis Range Complex Supersonic Flight Areas.

Civilian flights through MOA airspace, after receiving the latest NOTAM, are generally on a see-and-avoid responsibility.

MOAs are airspace with defined vertical and lateral limits established for the purpose of separating certain military aircraft activities from instrument flight rules (IFR) air traffic. Whenever a MOA is being used, non-participating IFR traffic may be cleared through a MOA if IFR separation can be provided by NATCF. Otherwise, NATCF will reroute or restrict non-participating IFR traffic. Pilots operating under visual flight rules (VFR) should exercise extreme caution while flying within a MOA when military activity is being conducted. Pilots can contact any FSS within 100 miles of the area to obtain accurate real-time information including MOA hours of operation and current traffic advisories.

The following flight operations occur in Nellis Range Complex and may involve supersonic flight: (1) transition training, (2) instrument training, (3) formation training, (4) basic fighter maneuvers, (5) intercepts, (6) air combat maneuvers, (7) dissimilar aircraft combat training, (8) instructor pilot continuation training, (9) functional aircraft check flights, (10) low altitude navigation training, (11) air-to-air weapons training, (12) air-to-ground weapons delivery training, and (13) military exercises. Each flight training operation is described below.

- Transition Training - Transition training teaches aircrews already qualified in one type of aircraft to fly other types of aircraft. It provides the aircrew with the basic skills and knowledge of the handling characteristics of other aircraft types. Most transition training operations are conducted at subsonic airspeeds at altitudes between 5,000 feet above ground level (AGL) to FL 330 (33,000 feet MSL); however, some maneuvers may occur at altitudes above FL 330. Supersonic maneuvers performed during this training usually occur between 10,000 feet MSL and FL 250.

- Instrument Training - Instrument training provides the aircrew with skills and knowledge necessary to accomplish safe flight by reference to aircraft instruments. Instrument training is generally conducted at subsonic airspeeds at altitudes between 5,000 feet AGL and FL 330. Altitudes above FL 330 are sometimes used.

- Formation Training - During formation training, the aircrew develops the skills required to maneuver and fly an aircraft in close proximity to other aircraft. This training is generally conducted at subsonic speeds at altitudes between 5,000 feet AGL and FL 330. Altitudes above FL 330 are sometimes used.

- Basic Fighter Maneuvers (BFM) - BFM training provides pilots with the knowledge, skill, and proficiency to maneuver into the adversary's aircraft vulnerability envelope. The training is generally conducted at altitudes between 5,000 feet AGL and FL 330 although altitudes above FL 330 are regularly used. BFM training frequently involves supersonic flights between 10,000 feet MSL and FL 250.

- Intercepts - Intercept training teaches the aircrew to perform radar-directed intercepts to arrive at a position of tactical advantage. This type of training normally requires long range set-ups which culminate in air-to-air engagements. This training is conducted at altitudes from 10,000 feet MSL to FL 510 or higher.

- Air Combat Maneuvers (ACM) - ACM training provides aircrews with realistic air-to-air engagements involving more than two aircraft in a variety of tactical scenarios. This training is normally conducted at altitudes from 5,000 feet AGL to FL 330; however, altitudes above FL 330 are frequently used. Supersonic flight associated with ACM training may be conducted from 5,000 feet MSL to FL 510.

- Dissimilar Aircraft Combat Training (DACT) - In DACT the aircrew employs skills previously learned about intercepts, BFM, and ACM against one or more unpredictable dissimilar adversaries. This training is normally conducted at altitudes from 5,000 feet AGL to FL 330. Supersonic flight may occur anytime during DACT.

- Instructor Pilot Continuation Training (IPCT) - IPCT allows instructors to maintain and increase proficiency in a variety of flight operations. These sorties may include DACT, BFM, cross-country flight, or military exercises. This training is normally conducted at altitudes from 5,000 feet AGL to FL 510 and includes supersonic flights.

- Functional Aircraft Check Flights - Certain aircraft maintenance activities require an aircraft to be inspected and test flown by a qualified test pilot prior to its release for normal use. Such flights are known as functional aircraft check flights.

- Air-to-Air Weapons Delivery - These missions incorporate pursuit aircraft firing 20 millimeter target practice ordnance at a towed sleeve target. The target simulates enemy aircraft and provides live air-to-air gunnery experience. This training is typically conducted during the daytime at subsonic speeds and at a variety of altitudes and attitudes.

- Air-to-Ground Weapons Delivery - Simulated combat targets are fabricated from salvaged vehicles to provide pilots with realistic weapons delivery training. Authorized ordnance for delivery at selected targets include gun/cannon ammunition, inert rockets, heavyweight bombs, inert and high explosive bombs, and live missiles. Scoring of target hits on the range is recorded with a Television Ordnance Scoring System allowing the pilot immediate feedback from the ground range control scorer. Manned range air-to-ground targets simulate nuclear and conventional weapons delivery target training. A combination of five target types are used on the various target ranges: (1) tactical strafe, (2) strafe, (3) bomb/rocket circle, (4) simulated nuclear weapons delivery, and (5) applied tactics orientation. Pilot accuracy is graded by range personnel and on-site electronic scoring equipment.

- Military Exercises - Various military exercises (including Red Flag and Green Flag) are conducted throughout the year that involve various types of aircraft. The exercise may involve combined, joint, or multi-nation aircraft.

2.1.2.1 Airspace Usage

Approximately 65,000 sorties were flown in the Nellis Range Complex in 1993, an average of 5,400 sorties per month. Approximately 64 percent of the yearly sorties were flown by three types of aircraft, the F-15, F-16, and F-4. The number of sorties by aircraft type and the percent of total sorties is shown in Table 2-1.

Table 2-1

1993 Nellis Range Complex Operations

	Aircraft Type										
	F-4	F-5	F-14	F-15	F-16	F-18	F-111	A-6	A-10	Other	Helo
Annual Sorties	6,617	224	1,468	15,631	19,069	3,957	2,056	817	5,233	9,097	824
Percent of Sorties (Rounded)	10.2	0.4	2.2	24	29.3	6.0	3.2	1.3	8.1	14.0	1.3

The "other" category of aircraft type flew approximately 14 percent of the sorties. Most supersonic flights are conducted by F-4, F-5, F-14, F-15, F-16, F-18, and F-111 aircraft. Approximately 10 percent of the total flight time logged by these aircraft involves supersonic flight. Aircraft will obtain supersonic speeds for a brief period during the sortie. Approximately 5 percent of the supersonic flight time occurs during acoustical night, between 2200 and 0700 (Frampton et al. 1993a). Future flight operations would maintain the approximate number of 1993 sorties with the same relative percentage of supersonic flight time.

The airspace used most is R-4807A, followed by R-4806W and Desert MOA. Approximately 82 percent of the sorties are flown in these three airspaces. The number and percent of sorties for the MOAs and restricted areas are listed in Table 2-2.

Table 2-2

Use of Airspace, Nellis Range Complex

Airspace	Number of Sorties	Percent of Sorties (Rounded)
Reveille	3,940	6.1
Desert	14,874	22.9
R-4806E	3,165	4.9
R-4806W	16,386	25.2
R-4807	22,016	33.9
R-4808	2,493	3.8
R-4809	2,119	3.2

The ground target ranges below the four restricted areas have a wide variety of target installations for the delivery of air-to-ground weapons (see Figure 2-2). Live and inert ordnance, ammunition, flares, and rockets are expended from the air-to-ground weapons systems. Several of the target ranges are manned for the evaluation and scoring of weapons delivery accuracy. Some target ranges are used for bombing and utilize a variety of electronic warfare scenarios and radar-guided delivery systems. Additionally, the target ranges below the restricted areas are used for testing and evaluating new weapons systems. The two MOAs are used for a variety of aircraft operations but do not include the deployment of any munitions, ordnance, or release of other weapons.

2.1.2.2 Supersonic Flight

Supersonic flight is approved within certain designated airspace in the Nellis Range Complex (USAF 1994) based on the training requirement for realistic testing and training. Approximately 70 percent of the Nellis Range Complex airspace is authorized for supersonic flights (Figure 2-3). Supersonic flight is conducted only when necessary to accomplish the mission. Approximately 10 percent of the total sortie flight time flown by aircraft capable of supersonic flight is actually flown at supersonic speed. Supersonic flights are recorded in accordance with AFR 55-34. Supersonic flights over populated areas and other noise sensitive areas are avoided when these urban centers are located below airspace approved for supersonic flight. According to a recent noise study (Frampton et al. 1993b), the average sonic boom

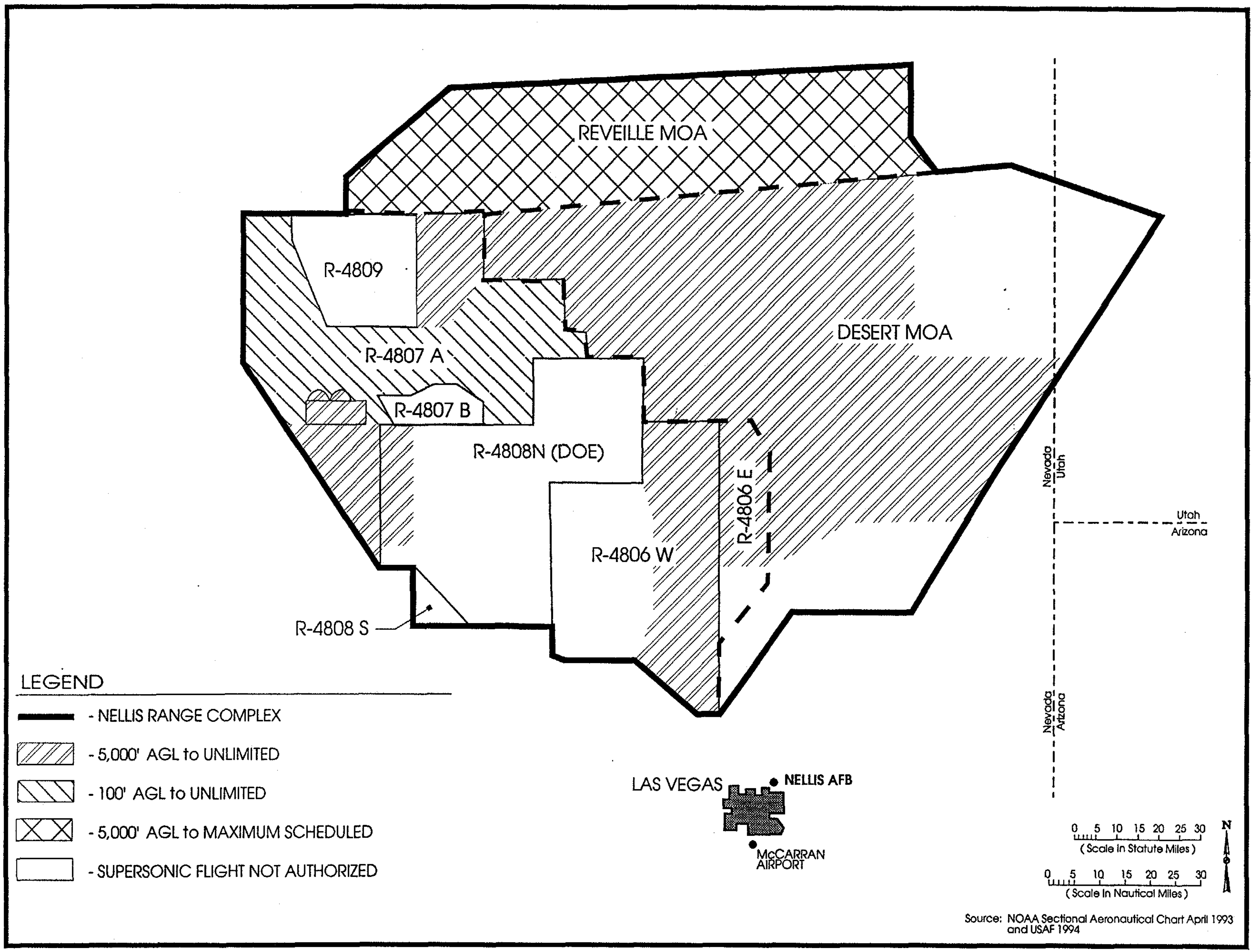


Figure 2-3. Nellis Range Complex Supersonic Flight Areas.

overpressure at the Nellis Range Complex is just under 1 psf. A small percentage of booms, 1.3 percent, has an amplitude in excess of 5 psf. These booms were rare, occurring at a given location at the rate of once or twice a year. At the center of the Elgin subdivision booms may be heard at an average rate of less than once per day. In other parts of the Nellis Range Complex subject to supersonic flight, booms may be heard an average of once or twice a week. The following airspace or portions of airspace are approved for supersonic flight within the Nellis Range Complex:

- Reveille MOA, from 5,000 feet AGL to the maximum flight level scheduled.
- Desert MOA:

  Caliente subdivision: the portion west of Longitude W114° 35′; 5,000 feet AGL to maximum scheduled altitude.

  Coyote subdivision: the entire area; 5,000 feet AGL to unlimited altitude.

  Sally Corridor subdivision: the portion north of Latitude N36° 52′; 5,000 feet AGL to unlimited altitude.

  Elgin subdivision: the portion north of a line from Latitude N36° 52′, Longitude W114° 50′ 43″ to Latitude N37° 04′, Longitude W114° 33′ to Latitude N37° 04′ and Longitude W114° 20′; 5,000 feet AGL to unlimited altitude.

- Restricted Areas:

  R-4806E: the portion north of Latitude N36° 52′; 5,000 feet AGL to unlimited altitude.

  R-4806W: above 5,000 feet AGL to unlimited altitude (area as shown on Figure 2-3).

  R-4807A: above 100 feet AGL to unlimited altitude (area as shown on Figure 2-3).

  Tolicha Peak Electronic Combat (TPEC) subdivision of R-4807A: 5,000 feet AGL to unlimited altitude.

The major portion of supersonic flight would occur between 5,000 feet AGL to an unlimited altitude. Supersonic flights are not authorized in most portions of R-4808 N & S and are not normally conducted in R-4809. Supersonic flights may be approved within these areas after coordination with the Sandia Corporation, the Manager of the DOE Nevada Nuclear Test Site, on a case-by-case basis. Once approved, supersonic flight would be conducted above 5,000 feet AGL in these areas. Other flight restrictions may apply and would be conveyed at the time of approval. Except for the extreme northern portion, all of R-4806E and R-4806W lie within the Desert National Wildlife Refuge (DNWR). The following special flight restrictions govern the use of these two areas within the July 1993 Memorandum of Understanding:

- Aircraft will remain above 2,000 feet AGL unless accomplishment of the mission specifically requires a lower altitude, and
- Air-to-air gunnery operations will be conducted above 10,000 feet MSL.
- No flight below 2,000 feet AGL within 0.5 nautical miles (NM) of wildlife watering points (as depicted on the Nellis Range chart as Noise Sensitive Areas [NSA]).

During the annual Bighorn Sheep Hunt on the DNWR, the following restrictions apply for R-4806E, R-4806W, and Sally Corridor subdivision of the Desert MOA:

- All flights will be above 15,000 feet MSL in R-4806E and in R-4806W.
- Flights in Sally Corridor west of Longitude 115° will be above 15,000 feet AGL.

Supersonic flights in the Nellis Range Complex are conducted in restricted airspace and MOAs that have been selected, evaluated, and approved by the USAF (1994). The criteria and requirements used in the supersonic airspace selection process are:

- Proximity to Base - Distance for optimum training value depends on the mission and type of aircraft. The goal is to provide maximum on-range time for the least amount of fuel expended in transit.

- Land Use Density - The area selected has a low population density to limit the number of people who would be potentially affected.

- Civilian Air Traffic - The area has minimum or no civilian air traffic to ensure safe operation of training flights without potential conflict with civilian air traffic.

- Airspace Usage Schedule - Airspace scheduling by one command or service avoids flight and range scheduling conflicts between services. Efficient scheduling results in maximum use of airspace and enhanced safety for each training operation.

- Scheduling Priority - The primary user has scheduling priority. There are minimal flight delays enroute, or while entering or exiting the airspace; this saves fuel and prevents excessive time in assigned airspace.

- Terrain Elevation - Ground elevation is preferably below 5,000 feet MSL. This provides aircraft the largest maneuvering envelope. Elevations between 5,000 and 10,000 feet MSL are acceptable although it restricts certain flight operations. Ground elevations above 10,000 feet MSL severely restrict flight operations. An area with high terrain elevation is generally not acceptable except as a secondary area for limited flight operations.

- Flight Ceiling - Depending on mission requirements, the airspace ceiling is 50,000 feet MSL or higher.

- Size - The optimum airspace size varies directly with mission and aircraft type. The airspace must be large enough to accommodate as many different types of aircraft as possible.

- Noise - The airspace is not located over noise sensitive areas such as large urban centers, highly populated areas, hospitals, schools, scenic areas, or high-use recreational areas.

2.2 Alternatives to the Proposed Action

Two alternatives to the proposed action have been identified for evaluation: (1) no action and (2) use another special-use airspace.

2.2.1 No Action

Under the no action alternative, supersonic flight operations below FL 300 within the Nellis Range Complex would cease. It would therefore be mandatory that supersonic flight operations by all Department of Defense (DOD) services in the Nellis Range Complex be conducted above FL 300 as directed by USAF policy. As a result, reissuance of the waiver to AFR 55-34 would not be required.

2.2.2 Use Another Special-Use Airspace

Under the "use another special-use airspace alternative," the existing waiver would expire at the Nellis Range Complex, and aircrews would have to fly to other existing but distant special-use areas in which supersonic flights below FL 300 are approved. The closest supersonic airspace to Nellis AFB is in southern Arizona and in southern California. These areas are approximately 240 NM and 180 NM, respectively, from Nellis AFB. Another consideration was the use of the National Defense Operation Areas (Warning Areas) over the Pacific Ocean, off the southern California coast. These warning areas are over international waters. The areas in or off the southern California coast would subject aircrews to flying through some of the most congested airspace in the United States. Activities conducted in warning areas could be as hazardous to non-participating aircraft as those activities conducted in restricted areas.

Scheduling opportunities and prioritization of special-use airspace controlled by other commands and services is also of concern. In all cases, the greater distance of other special-use airspace from Nellis AFB would necessitate increased flying time and fuel consumption, possibly requiring air-refueling support. These factors could potentially reduce the amount and quality of training opportunities for USAF pilots.

Ideally, the location of the supersonic airspace should provide maximum time in the airspace for the least amount of fuel expended in transit. The alternative of using another special-use airspace would not meet the major criteria of having the supersonic airspace in close proximity to Nellis AFB for optimum training value. As a result, this alternative was not carried forward for further, detailed analysis.

3.0 AFFECTED ENVIRONMENT

3.1 Land Use and Population

The Nellis Range Complex encompasses large portions of Clark, Lincoln, and Nye counties in southern Nevada and small portions of Iron and Washington counties in southwest Utah (Figure 3-1). Approximately 95 percent of the Nellis Range Complex is in the State of Nevada. Almost all of the government-owned Nellis Air Force Range land, approximately 6,100 square miles (3,904,000 acres), lies below restricted area. The non-Range lands, approximately 11,950 square miles (7,648,000 acres), are both government and privately owned, and make up the remaining portion of the Nellis Range Complex. The non-Range lands lie primarily below the MOAs.

3.1.1 Land Use

Land use on the Nellis Air Force Range and on DOE's Nevada Nuclear Test Site is directly related to a variety of military flight operations or energy-related projects. The land within these two areas is approximately 42 percent of the total land in the Nellis Range Complex.

The major land use below the MOAs is government-controlled open range land which is used for the limited production of cattle and other livestock. Other land use includes small towns and settlements, transportation facilities, and National Wildlife Refuges (NWR) and Wildlife Resource Areas (WRAs). Included in some of these wildlife areas are small recreational areas. The NWRs and WRAs are distributed throughout the eastern portion of the Nellis Range Complex. Clark, Lincoln, and Nye counties are predominantly rural, with scattered and widely separated small communities, farms, and ranches.

3.1.2 Land Ownership

The USAF directly controls approximately 6,100 square miles, the Nellis Air Force Range, and the DOE Nevada Nuclear Test Site, approximately 2,660 square miles in the Nellis Range Complex, approximately 42 percent of the total land. These two restricted areas underlie the restricted airspace. Access to this land is highly restricted and strictly controlled, however, some of the government land is used for

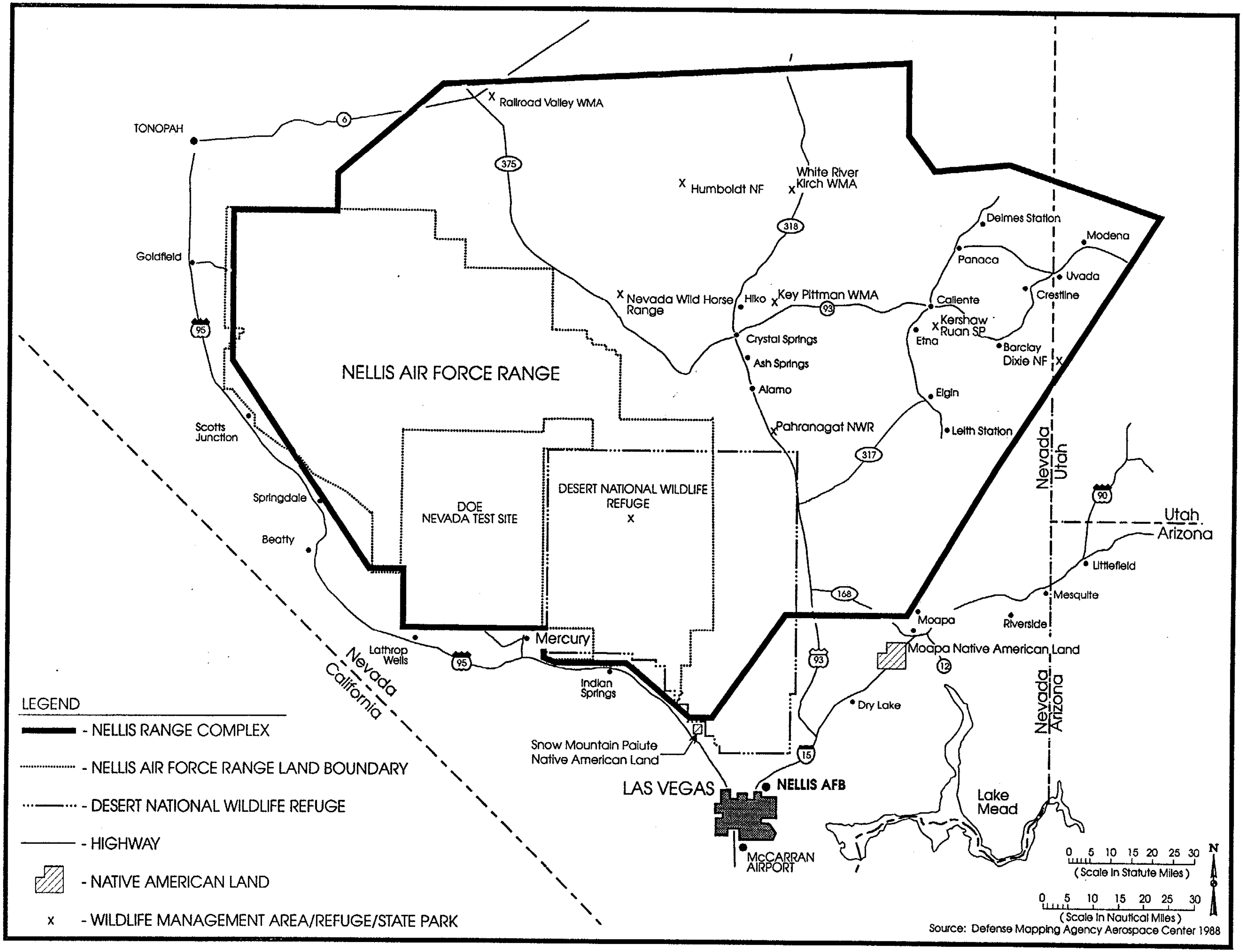


Figure 3-1. Land Use Nellis Range Complex, Wildlife Management Area/Refuge.

grazing. There is very little private land below the restricted areas. The land below the MOAs, approximately 11,950 square miles, is mostly controlled by the federal government with some areas controlled by the state government and limited private land. Access to the private land is controlled by the owner or a local agent. Access to public land below the MOAs is generally unrestricted. There are two Native American lands near the Nellis Range Complex. The Moapa Native American Nation owns land near the southern portion of Desert MOA and the Snow Mountain Paiute owns land south of R-4806W (see Figure 3-1). Sixty-seven percent of the land in Clark County is public land administered by the Bureau of Land Management (BLM). Approximately 58 percent of the land in Nye County is administered by BLM and most of the Nye County public land is in large continuous areas. Private land holdings are relatively small (USDOI 1992).

3.1.3 National Wildlife Refuges and Resource Areas

Various agreements and memorandums of understanding have been executed between the USAF and various federal and state agencies. These documents allow the use of the Nellis Air Force Range for the mutual benefit of wildlife and recreational land users (SAIC 1991). The use of the Nellis Air Force Range by federal and state agencies for a variety of land uses is an important aspect of the USAF's "good neighbor policy" and interagency cooperation.

Approximately 18 WRAs and NWRs are either totally or partially located below the airspace of the Nellis Range Complex (see Figure 3-1). The total area of the WRAs is approximately 3,500 square miles (2,240,000 acres). Approximately 70 percent of the WRAs, 2,415 square miles, are below airspace approved for supersonic flights. Approximately 17 percent of the Nellis Range Complex airspace is above the WRAs and NWRs.

Several federal agencies administer the WRAs and NWRs below the Nellis Range Complex. The U.S. Fish and Wildlife Service (USFWS) administers approximately 1,255,497 acres, the U.S. Forest Service administers approximately 57,000 acres, and the BLM administers 927,503 acres. The area administered by the three agencies is approximately 17 percent of the land in the Nellis Range Complex.

3.1.4 Population

Clark County is the most urban of the three counties and contains two-thirds of the state's population. Lincoln and Nye counties are predominantly rural counties with low population densities (Table 3-1).

Table 3-1

Population for Counties in Nevada

County	Population	Area (square miles)	Population Density (per square mile)
Clark	741,459	7,911	94.0
Lincoln	3,775	10,635	0.4
Nye	17,781	18,147	1.0
Total/Average	763,015	36,693	20.8

Source: U.S. Department of Commerce 1991a, 1991b

The land below the restricted area has no permanent population, towns, or settlements. Small isolated communities occur throughout the area beneath the MOAs (Table 3-2). The Snow Mountain Paiute Native American land does not have a permanent population.

3.2 Air Quality

3.2.1 Introduction

Air quality in a given location is described by the concentrations of various pollutants in the atmosphere expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). The significance of a pollutant concentration is usually determined by comparison with federal and/or state air quality standards. These standards represent allowable pollutant levels that protect public health and welfare with a reasonable margin of safety. Federal standards are established by the Environmental Protection Agency (EPA) and termed the National Ambient Air Quality Standards (NAAQS). The NAAQS are defined

Table 3-2

Urban Areas in the MOAs, Nellis Range Complex

Communities	Population
Alamo	250
Amargosa Valley	761
Beatty	450
Caliente	1,000
Carp	25
Elgin	25
Goldfield	300
Hiko	15
Moapa	20
Modena (UT)	35
Pioche	650
Tonopah	4,200
Uvalda (UT)	10

Source: U.S. Department of Commerce 1991b; U.S. Department of the Interior 1970

as the maximum acceptable ground-level concentrations that may not be exceeded more than once per year, except for annual standards which may never be exceeded. These standards include concentrations for ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), and lead (Pb). The Nevada Division of Environmental Protection has adopted the NAAQS, in addition to promulgating state ambient air quality standards for SO_2 and total suspended particulates (TSP) to regulate air pollutant levels. The federal and Nevada ambient air quality standards are shown in Table 3-3. The pollutants considered in this EA are CO, NO_2, O_3, PM_{10}, SO_2, and volatile organic compounds (VOC). VOCs are considered a precursor pollutant to ozone formation.

The EPA has designated all areas of the United States as having air quality better than (attainment) or worse than (non-attainment) the NAAQS. The criteria for non-attainment designation vary by pollutant: (1) an area is in non-attainment for O_3 if its NAAQS have been exceeded more than three discontinuous

Table 3-3

National and Nevada Ambient Air Quality Standards

Pollutant	Averaging Time	----National/Nevada Standards[a]---- Primary[b,c]	Secondary[b,d]	Nevada
Ozone	1-Hour	0.12 ppm (235 $\mu g/m^3$)	Same as Primary Standard	---
Carbon Monoxide	8-Hour	9 ppm (10 mg/m^3)	---	---
	1-Hour	35 ppm (40 mg/m^3)	---	---
Nitrogen Dioxide	Annual	0.053 ppm (100 $\mu g/m^3$)	Same as Primary Standard	---
Sulfur Dioxide	Annual	80 $\mu g/m^3$ (0.03 ppm)	---	60 $\mu g/m^3$ (0.02 ppm)
	24-Hour	365 $\mu g/m^3$ (0.14 ppm)	---	---
	3-Hour	---	1,300 $\mu g/m^3$ (0.5 ppm)	---
Total Suspended Particulates	24-Hour	---	---	150 $\mu g/m^3$[e]
PM_{10}	Annual	50 $\mu g/m^3$[f]	Same as Primary Standard	---
	24-Hour	150 $\mu g/m^3$	Same as Primary Standard	---

Notes:

(a) Standards, other than for ozone and those based upon annual averages or annual arithmetic means, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year, with maximum hourly average concentrations above the standard, is equal to or less than one.

(b) Concentrations are expressed first in units in which they were promulgated. Equivalent units given in parenthesis are based upon on a reference temperature of 25° C and a reference pressure of 760 mm of mercury (1,013.2 millibar). All measurements of air quality are corrected to a reference temperature of 25° C and a reference pressure of 760 mm of mercury; in this table $\mu g/m^3$ = micrograms per cubic meter, mg/m^3 = milligrams per cubic meter, and ppm = parts by million by volume, or micromoles of pollutant per mole of gas.

(c) Primary Standard: The level of air quality necessary, with an adequate margin of safety, to protect public health. Each state must attain the primary standards no later than 3 years after that state's implementation plan is approved by the EPA.

(d) Secondary Standard: The level of air quality necessary to protect public welfare from known or anticipated adverse effects of a pollutant. Each state must attain the secondary standard within a "reasonable time" after the implementation plan is approved by EPA.

(e) The 24-hour TSP standard for Nevada is 150 $\mu g/m^3$, except for the Las Vegas metropolitan area, which is 260 $\mu g/m^3$.

(f) Calculated as arithmetic mean.

times in three years, and (2) an area is in non-attainment for any other pollutant if its NAAQS have been exceeded more than once per year.

In Nevada, Clark County is in non-attainment for PM_{10} and "moderate" non-attainment for CO. In addition, Washoe County is in "marginal" non-attainment for O_3 and "moderate" non-attainment for CO and PM_{10}. The remainder of the state is in attainment (Bryant 1994).

The Clean Air Act (CAA) established the Prevention of Significant Deterioration (PSD) regulations to protect the air quality in regions that already meet the NAAQS. The major requirement for the PSD regulations is that the air quality impacts from new or modified PSD sources in combination with air quality impacts from other PSD sources must not exceed the maximum allowable incremental increases for NO_2, PM_{10}, or SO_2 as identified in Table 3-4. Certain national parks, monuments, and wilderness areas have been designated as Class I areas, where appreciable deterioration in air quality is considered significant. Class II areas are those areas where moderate, well-controlled industrial growth could be permitted. There is one PSD Class I area in Nevada: the Jarbridge Wilderness Area (located 150 miles to the northeast of the Nellis Range Complex) and there are five Class I areas in Utah: Arches, Bryce Canyon, Canyonlands, Capitol Reef, and Zion National Parks. The closest Class I area in Utah, Zion National Park, is approximately 37 miles east of the Nellis Range Complex while the remaining Class I areas are more than 50 miles from the Nellis Range Complex.

The CAA also provides that a federal agency cannot support any activity that does not conform to an EPA-approved State Implementation Plan (SIP). A SIP is developed by a state to detail how the state will control emission sources to bring an area of non-attainment into attainment. The plan includes a baseline emissions inventory, control measures that will reduce future emissions, and projected emissions inventories that are adjusted for increases in growth and reductions in emissions due to the implementation of control measures. Congress explained that conformity to the SIP means conforming to the SIP's purpose of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards.

In November 1993, EPA developed the final rules for determining conformity (FR 63214). Under the rules, certain actions are explicitly given exemptions from preparing conformity determinations while

Table 3-4

Maximum Allowable Incremental Increases Under PSD Regulations

Pollutant	Averaging Time	PSD Increments ($\mu g/m^3$) Class I	Class II
Nitrogen Dioxide	Annual	2.5	25
PM_{10}	Annual	4	17
	24-Hour	8	30
Sulfur Dioxide	Annual	2	20
	24-Hour	5	91
	3-Hour	25	512

others are assumed to be in conformity if total project emissions are below de minimis levels. Total project emissions include direct emissions and indirect emissions that a federal agency can control. The de minimis emissions levels for areas of non-attainment are presented in Table 3-5, while de minimis emissions levels for maintenance areas are presented in Table 3-6. If total project emissions from a federal action exceed the de minimis levels, the action is considered to be in conformity if one of the following requirements are met: (1) total project emissions are accounted for in the applicable SIP; (2) for O_3 and NO_2, total project emissions are offset so there is no net increase in emissions; (3) for criteria pollutants other than O_3 and NO_2, dispersion modeling of project emissions shows no violations of the NAAQS; (4) for O_3 and NO_2, where EPA has approved a revision to an area's attainment/maintenance plan after 1990 (a) the federal activity emissions plus baseline emissions would not exceed the emissions budget in the applicable SIP, or (b) when the federal activity emissions plus baseline emissions exceeds the emissions budget in the applicable SIP, the state governor provides a written commitment to revise the SIP to include the emissions; (5) for O_3 or NO_2, where EPA has not approved a revision to an area's attainment/maintenance plan after 1990, the federal activity emissions will not increase emissions with respect to the baseline emissions; or (6) for O_3 and NO_2, the federal activity is specifically included in a current transportation plan.

Table 3-5

De Minimis Exemption Levels for Conformity Determinations in Non-Attainment Areas

Pollutant/Non-attainment Classification	Emissions (Tons/Year)
Ozone (VOCs and NO_x)	
Serious	50
Severe	25
Extreme	10
Other ozone NA areas outside an ozone transport region	100
Marginal and moderate NA areas inside an ozone transport region	
VOC	50
NO_x	100
Carbon Monoxide	
All classifications	100
SO_2 or NO_2	
All classifications	100
PM_{10}	
Moderate	100
Serious	70

Table 3-6

De Minimis Exemption Levels for Conformity Determinations in Maintenance Areas

Pollutant	Emissions (Tons/Year)
Ozone (NO_x), SO_2, or NO_2 - All Maintenance Areas	100
Ozone (VOCs)	
Maintenance Areas inside an O_3 transport region	50
Maintenance Areas outside an O_3 transport region	100
Carbon Monoxide - All Maintenance Areas	100
PM_{10} - All Maintenance Areas	100

3.2.2 Baseline Emissions

There were approximately 65,000 sorties flown in 1993 at the Nellis Range Complex with 25,000 (i.e., approximately 38 percent) of those sorties being supersonic sorties (i.e., at least a portion of the sortie was conducted in supersonic flight mode) (Appendix A). Emissions generated by aircraft sorties in the Nellis Range Complex are presented in Table 3-7. In 1993, aircraft flying in the Nellis Range Complex produced 695.4 tons per year of CO, 52.1 tons per year of hydrocarbons (HC), 8,983.2 tons per year of NO_2, 213.5 tons per year of SO_2, and 229.9 tons per year of PM_{10}.

Table 3-7

Baseline Aircraft Emissions in the Nellis Range Complex

	Emissions (Lbs/Year)				
Plane Type	CO	HC	NO_x	SO_2	PM_{10}
A-6	6,412.5	8,399.5	117,592.6	4,877.1	0.0
A-10	46,254.0	2,011.0	201,104.2	10,859.6	1,005.5
F-4	519,885.8	9,653.8	1,033,790.6	54,628.7	89,113.3
F-5	60,316.0	1,637.1	5,393.9	1,125.4	37.1
F-14	35,286.5	11,917.3	302,948.4	8,891.3	45,088.1
F-15	321,831.2	23,868.0	6,455,308.1	142,189.3	84,326.2
F-16	173,159.7	15,004.6	4,055,131.6	85,762.7	52,146.4
F-18	71,116.2	14,829.2	1,202,333.1	26,120.3	133,334.4
F-111	26,659.6	2,787.0	780,893.8	15,933.9	6,918.0
Helicopters	3,070.2	30.7	7,880.2	552.6	0.0
Other	126,800.8	14,089.0	3,804,024.3	76,080.5	47,902.5
Total	1,390,792.5	104,227.2	17,966,401.0	427,021.5	459,871.5
Total (Tons/Year)	695.4	52.1	8,983.2	213.5	229.9

3.3 Noise

3.3.1 Introduction

The type of noise which is of concern in the Nellis Range Complex is sonic booms from supersonic flight. Sonic booms have been studied by modeling supersonic operations and by six months of continuous measurements in the Elgin subdivision of Desert MOA. Noise from subsonic operations has been studied by modeling operations for one year and combining this with the USAF's extensive database of subsonic aircraft noise.

Section 3.3.2 provides an overview of noise and its descriptors. Section 3.3.3 contains background information on sonic booms. Section 3.3.4 summarizes the sonic boom monitoring and analysis performed. Section 3.3.5 provides a description of the subsonic noise analysis.

3.3.2 Quantification of Noise

Noise is defined as an undesirable or unwanted sound. Sound consists of minute pressure waves which travel through the atmosphere and are sensed by the ear. Sound becomes noise when it is unexpected or annoying. The amount of annoyance that a specific noise causes depends on the physical characteristics of that sound, but also on the listener's current activity, past experience, and attitude toward that sound. Estimates of adverse impact are based on the average reaction of many people to a sound of given physical characteristics. The key physical characteristics are the intensity or amplitude (expressed as sound pressure), frequency (expressed as cycles per second or Hertz [Hz]), and duration. Complex sounds, such as an aircraft flyover whose amplitude and frequency content change with time, are quantified by metrics which account for the total or average properties.

The range of sound intensity that can be comfortably detected by the human ear covers a span of 1:1,000,000,000,000. Because of the unwieldiness of the numbers involved, sound amplitude is usually expressed as a level on the logarithmic decibel scale (dB). Sound level is defined as 10 times the common logarithm of the sound intensity divided by a reference intensity. The reference intensity is close to the threshold of human hearing, so that this threshold corresponds to 0 dB. The upper range of

1,000,000,000,000 times the threshold corresponds to a level of 120 dB. A change in sound level of 10 dB corresponds to a factor of 10 in sound energy and is perceived as a doubling or halving of loudness.

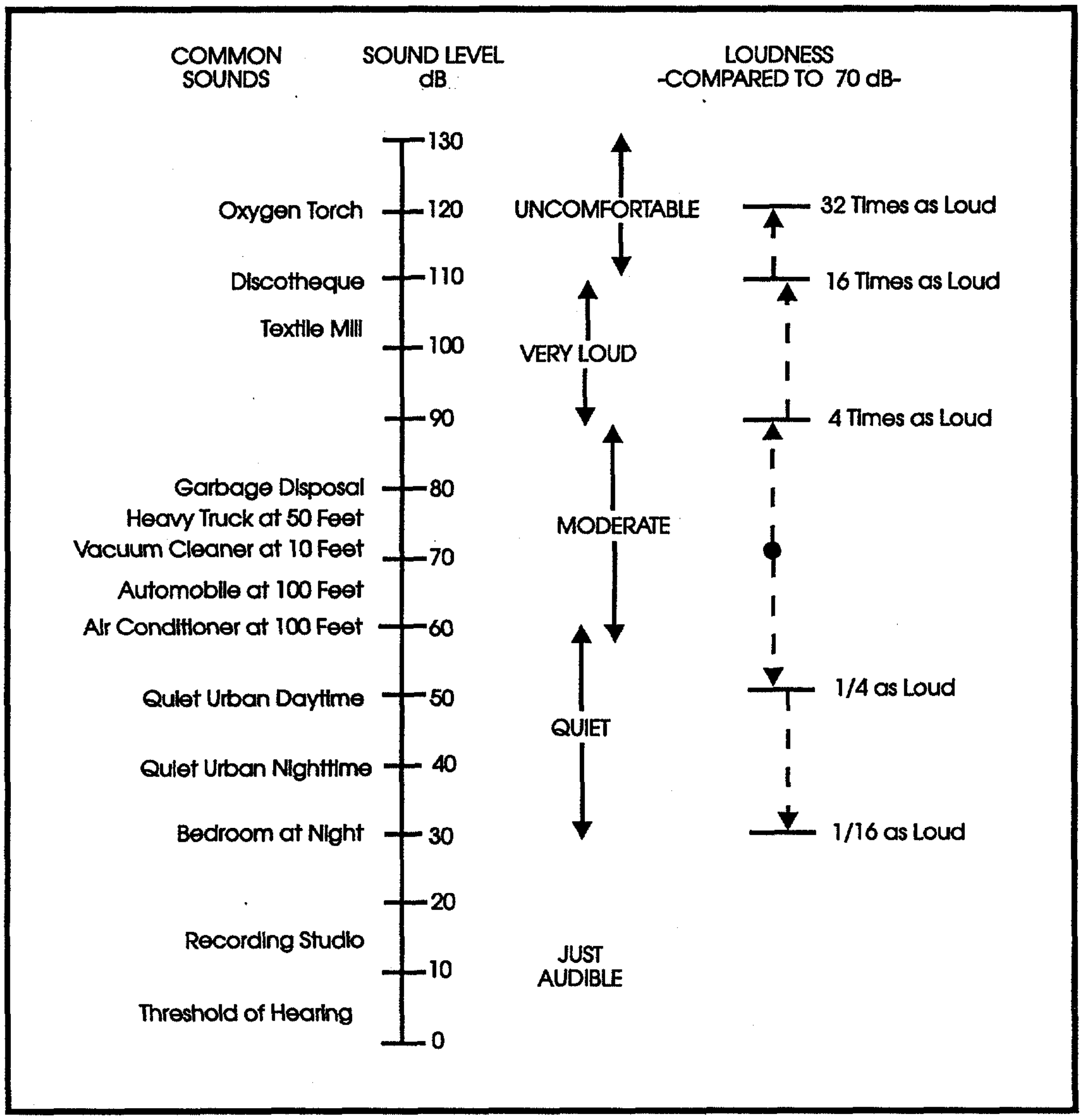
The human ear can detect sounds in the frequency range of about 20 to 20,000 Hz, but is most sensitive to the 1,000 to 4,000 Hz range. A filter network denoted A-weighting (ANSI 1988) approximates the sensitivity of the human ear. Environmental sounds are generally reported as A-weighted levels, i.e., the sound level obtained after passing through an A-weighting filter. Figure 3-2 shows A-weighted sound levels for some common sounds (Harris 1979). The unit for A-weighted sound levels is the decibel (dB) although the notation dBA or dB(A) is often used as a reminder that the sounds are A-weighted.

The perception of high-amplitude impulsive sounds such as sonic booms is somewhat different, with frequency content playing a less important role. Impulsive sounds are best quantified by C-weighting (ANSI 1988; ASA 1986), which is flat over most of the range of human hearing. The unit of C-weighted sound level is the decibel (dB) but the notation dBC or dB(C) may also be used. Sonic booms are often described directly by the peak pressure, either as pounds per square foot (psf) or on the decibel scale as L_{pk}.

The total effective magnitude of a given event (such as a single flyover or single sonic boom) is quantified by the sound exposure level (SEL), which is obtained by integrating the total sound energy of the event, normalizing to one second, and expressing it as a level. The SEL of a one second long event is equal to the average sound level of that event. SEL of a 10 second long event is 10 dB higher than the average sound level, corresponding to 10 times the energy. The notation SEL corresponds to A-weighted sound levels. When applied to C-weighted sounds, the notation CSEL is used.

Sound exposure level is a composite metric which accounts for both the amplitude of a sound and its duration. It does not directly represent the sound level heard at a given time, but rather provides a measure of the net impact of an individual sound. Numerous studies, both in the laboratory and the real world, have established that SEL quantifies this impact much more reliably than just the instantaneous sound level.

A number of sounds usually occurs over the course of a day. These are accounted for by various types of averages. The most widely accepted daily average is the Day-Night Average Sound Level (L_{dn}). This



Source: Harris 1979

Figure 3-2. Typical A-Weighted Sound Levels of Common Sounds.

metric is the average sound level (averaging being performed on the intensity, just as SEL is an integration of intensity), with sounds during the night (before 0700 and after 2200) adjusted upward by 10 dB to account for people's greater sensitivity to noise at night. The notation L_{dn} always corresponds to A-weighted sound levels. When applied to C-weighted sounds, the notation L_{Cdn} is used. Note that L_{dn} (or L_{Cdn}) does not correspond to the sound level heard at any specific time, but measures the total noise over the course of a day, accounting for the loudness of individual sounds, the duration of each sound, and the number of sounds. This quantity correlates very well with the adverse impact of noise on communities (Schultz 1978) (Figure 3-3). Noise impact within this study is quantified by L_{dn} for conventional aircraft noise and by L_{Cdn} for sonic booms.

3.3.3 Sonic Boom

An aircraft traveling at supersonic speed creates a disturbance that propagates away from the aircraft in a conical pattern (Figure 3-4). As the disturbance propagates, it tends to distort into the N-wave pressure signature shown at the ground in Figure 3-4. An N-wave consists of a shock wave (i.e., a sudden jump) up to a peak overpressure, a linear expansion to a negative pressure approximately equal to the peak, then a second shock up to ambient pressure. Depending on altitude, flight parameters, and aircraft type, the peak overpressure of an N-wave from military supersonic operations usually falls in the range from a few tenths of a psf to several psf. Durations (time between the two shock waves) range from 100 to 200 msec. The magnitude of a sonic boom is usually stated as its peak overpressure, or (for human impact assessment) as its CSEL. The magnitude of a sonic boom from an F-15 in steady level flight at 5,000 feet AGL is about 8.5 psf (CSEL = 120 dB), and at 30,000 feet AGL is about 2 psf (CSEL = 107 dB). These magnitudes occur directly under the flight path and are less to either side.

The cone in Figure 3-4 is referred to as the Mach cone. The N-waves sketched lie on a parabolic curve where the cone intersects the ground. This represents the boom which occurs at a given time. The boom pattern moves with the aircraft, so a footprint often referred to as a boom "carpet" is swept out along the ground as the aircraft moves. Figure 3-4 is somewhat idealized in that the Mach cone is shown as a perfect cone. Temperature gradients and winds in the atmosphere tend to distort the cone and the ground intercept, and cause some variation in boom amplitude and carpet width.

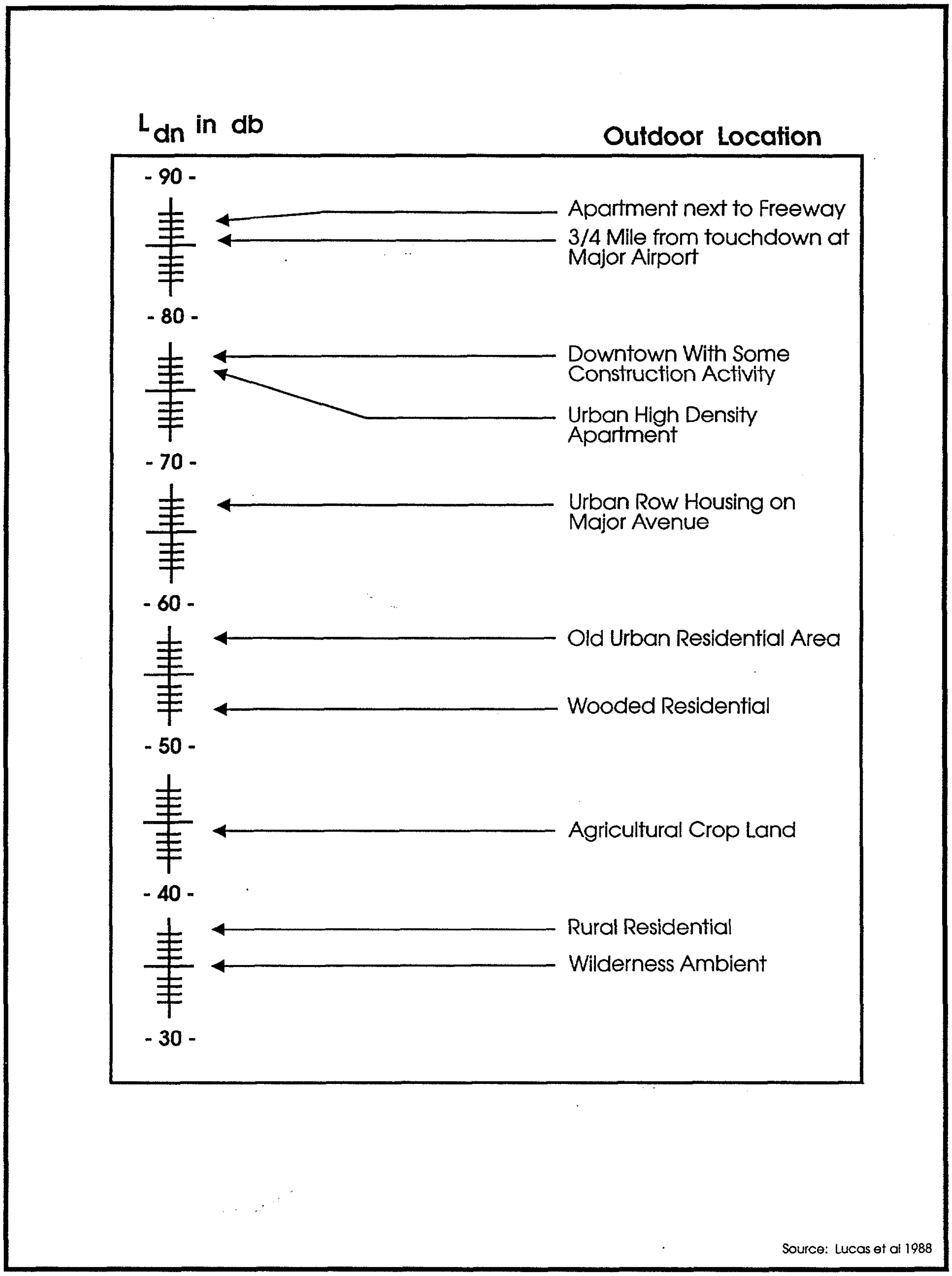


Figure 3-3. Typical Day-Night Noise Levels for Various Outdoor Environments.

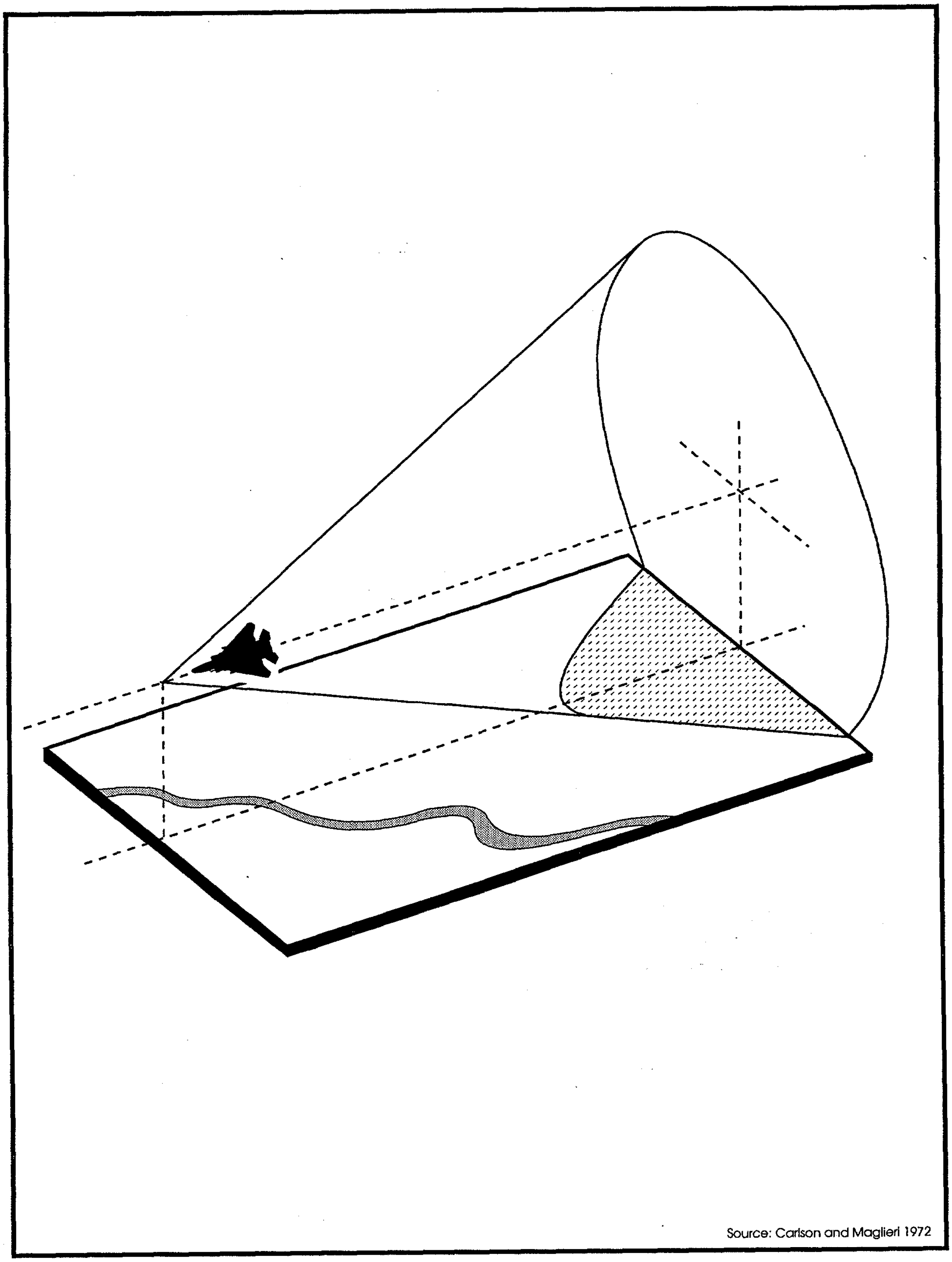


Figure 3-4. The Sonic Boom Pressure Field.

Figure 3-4 is drawn for steady level flight. Air combat training involves brief supersonic events, always associated with maneuvers, so the steady carpet boom condition is approximated only briefly. Boom footprints tend to be small, and there are distorted booms around the edges of the footprints. Some of these distorted booms are amplified and are referred to as "focus booms" or "superbooms." All of the phenomena are well understood and can be calculated if the maneuvers are known, but predictions can be difficult because of the random nature of maneuvers in air combat training. For this reason, sonic boom was studied primarily by means of measurements in the Elgin subdivision (Frampton et al. 1993b). It was also studied by use of software which combined ACMI tracking data with analytic sonic boom models (Plotkin et al. 1993). The analytic models correlated flight parameters of individual flights with measured sonic booms.

3.3.4 Sonic Boom Environment

Sonic boom measurements were conducted in the Elgin subdivision of the Desert MOA from 1 April 1992 through 30 September 1992. Measurements were made at the sites shown in Figure 3-5. A complete discussion of that study is contained in a separate report (Frampton et al. 1993b). The results of that study are summarized here.

As discussed earlier, individual sonic booms are characterized by their magnitude - either in terms of overpressure or CSEL. Because boom magnitudes tend to be well below the threshold of physical damage, the dominant adverse impact is expected to be annoyance of people living under the airspace. Annoyance due to sonic booms or other impulsive sounds is best quantified by L_{Cdn}, the day-night average C-weighted sound level (CHABA 1981). This is a cumulative measure that accounts for the magnitude of individual booms and also the number of booms. Mathematically, it represents the average C-weighted sound level, with a 10 dB penalty added to events at night (after 2200 and before 0700). The average is taken on an "energy" basis, which tends to emphasize the significance of the louder events.

Table 3-8 is a summary of the measurement results at all sites. The primary result is L_{Cdn}, shown in the rightmost column. This quantity is based on the number of days for which each site was operating, shown in the second column. Table 3-8 also shows the number of booms at each site and statistical summaries (averages and maxima) of the individual booms. The average boom was around 1 psf.

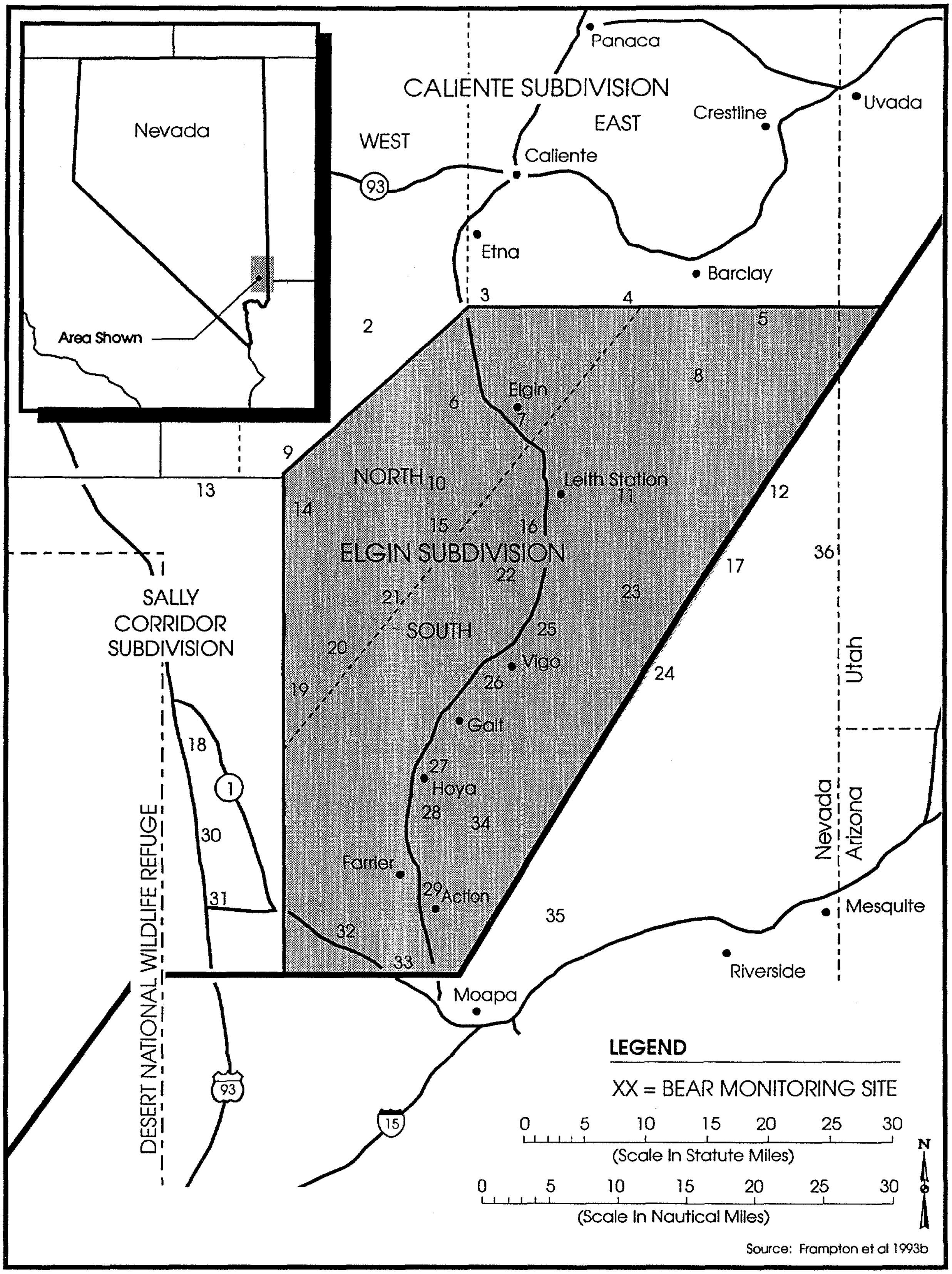


Figure 3-5. Elgin Subdivision Monitor Site Locations.

Table 3-8

Elgin Subdivision Individual Site Statistics

Site No.	Operating Days	No. of Booms			Overpressure (psf)			L_{pk} (dB)		CSEL (dB)		L_{cdn} (dB)
		Total	Day	Night	Max.	Avg.	No. >5 (psf)	Max.	Eng. Avg.	Max.	Eng. Avg.	
1	166	17	15	2	2.25	0.75	0	135	127	110	103	44
2	159	19	18	1	2.02	0.67	0	134	126	109	101	43
3	141	16	14	2	1.59	0.79	0	132	127	112	106	47
4	149	67	67	0	8.62	0.85	1	146	131	120	105	52
5	174	27	27	0	7.42	1.06	1	145	133	120	107	50
6	183	27	24	3	2.95	0.75	0	137	128	113	105	48
7	119	33	31	2	7.01	1.37	1	145	134	124	112	57
8	161	44	43	1	3.31	0.83	0	138	128	112	102	47
9	131	19	18	1	2.20	0.82	0	134	128	119	107	49
10	181	70	61	9	7.33	1.05	1	145	131	122	108	55
11	148	78	77	1	5.37	1.05	2	142	131	118	106	54
12	180	29	29	0	1.43	0.49	0	131	123	104	97	40
13	157	21	20	1	3.86	0.77	0	139	129	123	110	52
14	130	21	21	0	1.57	0.61	0	132	125	105	97	40
15	161	106	98	8	8.76	0.98	2	146	132	121	106	54
16	177	56	51	5	6.43	1.04	1	144	131	119	108	53
17	153	27	24	3	11.03	1.05	1	149	135	124	110	53
18	118	8	8	0	1.91	0.66	0	133	126	108	100	39
19	166	31	30	1	2.98	0.80	0	137	128	114	103	47
20	187	59	55	4	4.12	0.83	0	140	129	114	104	49
21	172	68	64	4	4.16	0.97	0	141	130	116	106	52
22	92	63	60	3	5.34	1.02	1	142	131	118	107	56
23	150	60	56	4	4.01	0.82	0	140	129	117	106	53
24	191	42	40	2	2.03	0.64	0	134	125	113	101	45
25	107	59	59	0	19.36	1.75	3	153	138	129	113	61
26	157	60	59	1	6.26	1.16	2	144	132	121	108	55
27	113	29	28	1	7.55	1.01	1	145	132	124	112	56
28	94	14	14	0	7.87	1.46	1	146	135	122	111	54

Table 3-8
(Continued)

Elgin Subdivision Individual Site Statistics

Site No.	Operating Days	No. of Booms			Overpressure (psf)			L_{pk} (dB)		CSEL (dB)		L_{cdn} (dB)
		Total	Day	Night	Max.	Avg.	No. >5 (psf)	Max.	Eng. Avg.	Max.	Eng. Avg.	
29	159	43	43	0	3.40	0.74	0	138	128	114	103	48
30	148	4	4	0	0.80	0.38	0	126	121	98	93	28
33	177	23	22	1	2.53	0.49	0	136	125	111	101	43
34	170	41	40	1	3.70	0.97	0	139	130	115	107	51
35	124	13	13	0	0.80	0.44	0	126	122	101	96	37
36	90	3	3	0	0.69	0.41	0	124	121	97	93	29
37	171	22	21	1	2.34	0.60	0	135	126	109	99	41
Total	--	1,337	1,275	62	19.36	0.93	18	153	131	129	107	--

Eighteen booms (about 1.3 percent of the total) exceeded 5 psf. These 18 booms are summarized in Table 3-9.

The threshold of significant annoyance from sonic booms occurs at an L_{Cdn} value of 61 dB (CHABA 1981). This value occurred at Site 25. The L_{Cdn} at all other sites is at least 5 dB below this limit, which suggests that there should not be significant impact at the other locations.

The L_{Cdn} at Site 25 was dominated by one 19.36 psf boom; without this boom L_{Cdn} would have been 56 dB. The characteristics of this boom were such that it was determined to be a carpet boom from an aircraft operating below 5,000 feet AGL, as opposed to being a focus boom from an aircraft engaged in ACM above 5,000 feet AGL. Schedule data showed that the aircraft causing this boom was not scheduled for ACM, but was part of a flight passing through Elgin as part of another exercise. Because this boom did not cause any damage or generate any complaints, no further investigation was conducted. The boom was included in the statistical modeling of measurement results. Note that higher boom levels are rare, and on average a boom of 5 psf or greater will occur at any given location once or twice a year. None of the booms measured were of sufficient magnitude to pose any injury threat to humans, nor to

Table 3-9

Booms Greater Than 5 psf

Monitor Site No.	Date	Time	Maximum Overpressure (psf)	L_{pk} (dB)	CSEL (dB)
28	7 Apr 92	1055	7.87	145.5	121.8
25	8 Apr 92	1347	19.37	153.3	129.2
26	8 Apr 92	0815	5.71	142.7	120.6
26	8 Apr 92	1110	6.26	143.5	119.5
25	29 Apr 92	1244	8.30	146.0	119.6
25	29 Apr 92	1244	6.00	143.2	116.4
16	1 May 92	1338	6.43	143.8	119.2
22	14 May 92	0912	5.34	142.1	114.6
10	20 May 92	1424	7.33	144.9	118.3
15	20 May 92	1424	7.91	145.6	115.3
27	26 May 92	1807	7.55	145.2	120.4
4	23 Jun 92	1316	8.62	146.3	120.2
5	25 Jun 92	1346	7.42	145.0	120.0
17	25 Jun 92	1741	11.03	148.5	123.8
11	25 Aug 92	1321	5.37	142.2	118.4
7	10 Sep 92	1315	7.02	144.5	119.0
15	18 Sep 92	1740	8.76	146.4	121.4
11	24 Sep 92	1311	5.19	1141.9	115.7

pose any physical damage potential other than a small statistical possibility of glass breakage or plaster cracks.

Figure 3-6 shows L_{Cdn} contours fit to the measured data. These contours represent the existing sonic boom environment in Elgin, and also represent the environment which would continue for the proposed action of continuing these operations. The results shown in Figure 3-6 agree well with prior sonic boom

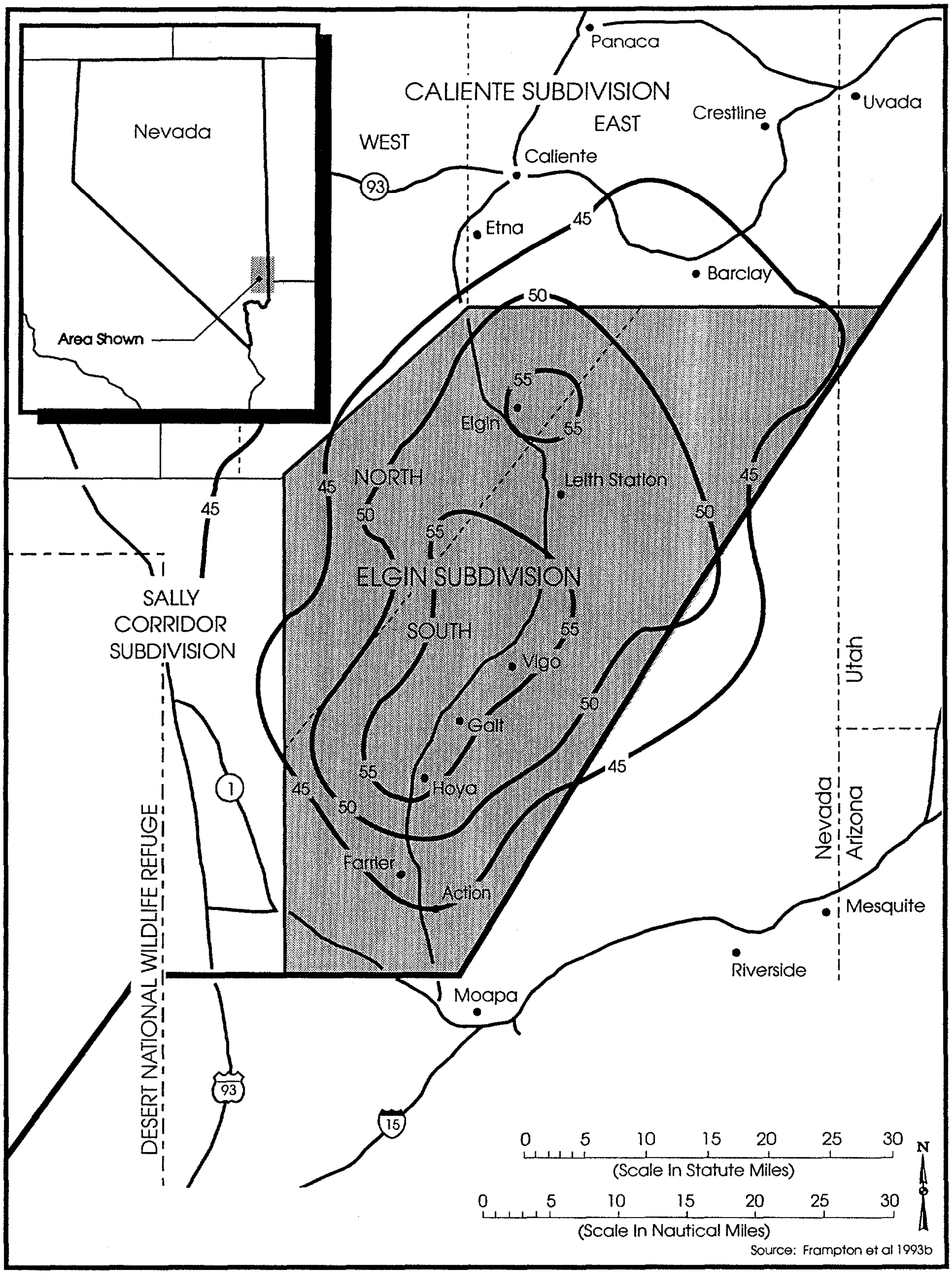


Figure 3-6. Elgin Subdivision L_{Cdn} Contours Based on Measured Sonic Booms.

measurements in ACM arenas, and have been merged into the planning model used for these areas (Frampton, Lucas, and Cook 1993). The updated model was used to predict the boom environment in the other areas. These predictions used the scheduled number of sorties, together with the number of supersonic-capable engagements per sortie in each area. The calculated L_{Cdn} in the other sections of the Nellis Range Complex was found to not exceed 50 dB. This value is sufficiently low that contours are not depicted. Individual booms comparable to those shown in Tables 3-8 and 3-9 would occur, although at a proportionately reduced rate.. Adverse impact is expected to be limited to annoyance from these occasional events.

3.3.5 Subsonic Noise Environment

Noise levels from subsonic operations were computed for the Nellis Range Complex. The analysis used the USAF's NOISEMAP technology together with RFMDS tracking data, ACMI tracking data, and Nellis AFB Range Control Group scheduling records. Details of this analysis are presented in a separate report (Frampton et al. 1993a). Figure 3-7 shows the computed L_{dn} contours. As discussed earlier, the cumulative impact of noise is most accurately represented by this metric. The threshold of adverse impact, in the form of annoyance, is generally associated with L_{dn} above 65 dB. The highest contour shown in Figure 3-7 is 60 dB, so that annoyance may occur but would not be at a significant level.

It has been established that L_{dn} values below 75 dB do not pose any threat of harm to humans - either hearing loss or physiological health effects (EPA 1972). The levels shown in Figure 3-7 are well below this value.

In addition to operations within the Nellis Range Complex, several Military Training Routes (MTRs) are located in this area. Operation data for three of these routes, whose locations are shown in Figure 3-8, were provided by 57th FG. Table 3-10 summarizes the cumulative noise metric L_{dnmr} computed for these routes. The calculations were performed with the USAF's ROUTEMAP noise model (Lucas and Plotkin 1988). The L_{dnmr} metric is similar to L_{dn} except that it is based on the busiest month of operations (rather than annual average) and includes a penalty of up to 5 dB to account for the increased annoyance associated with the high speed nature of MTR operations. The MTR noise levels shown in Table 3-10 are comparable to those within the range. They are not incorporated in the contours because the areas are too small for meaningful graphical depiction on a chart of the whole range.

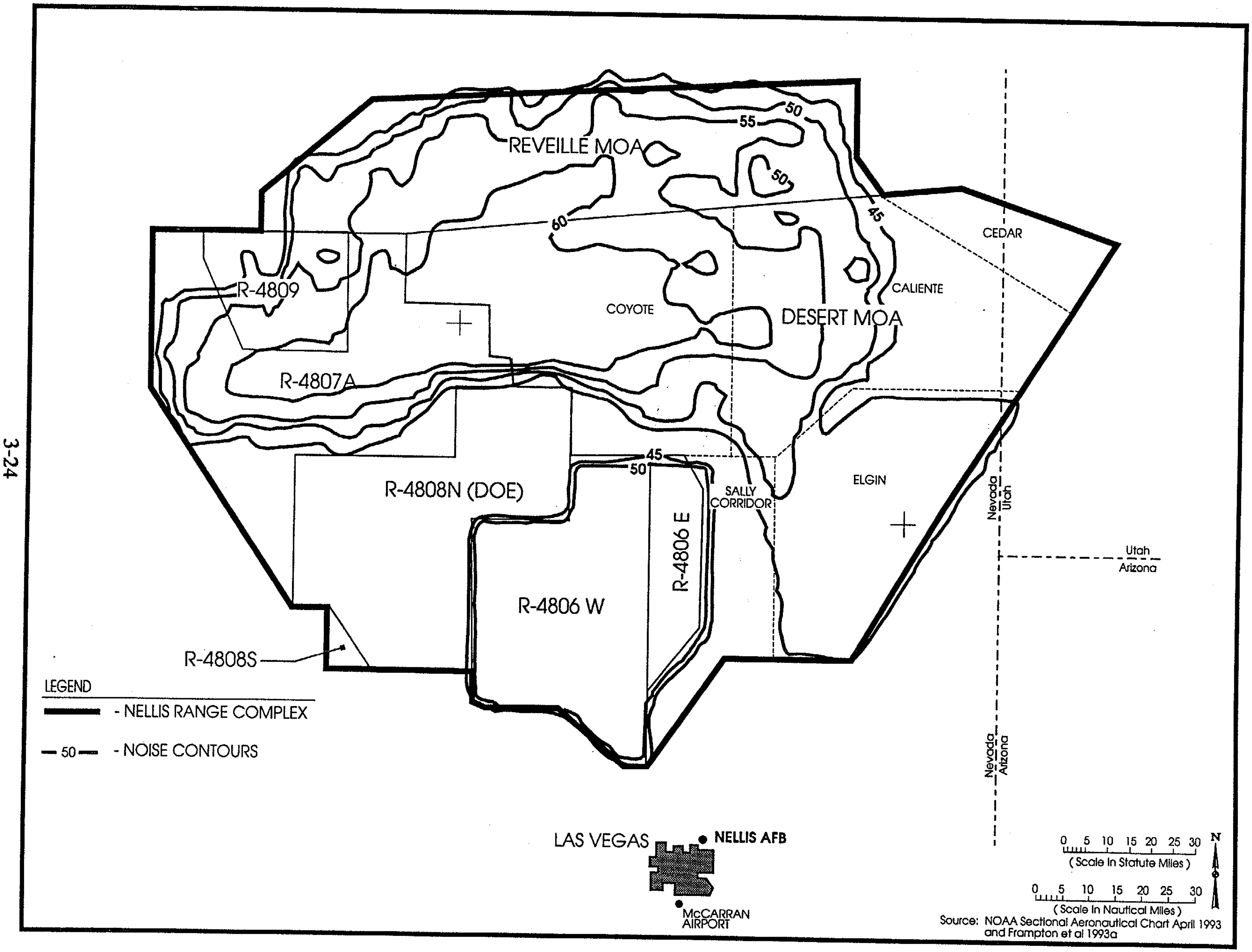


Figure 3-7. Composite L_{dn} Contours for the Nellis Range Complex.

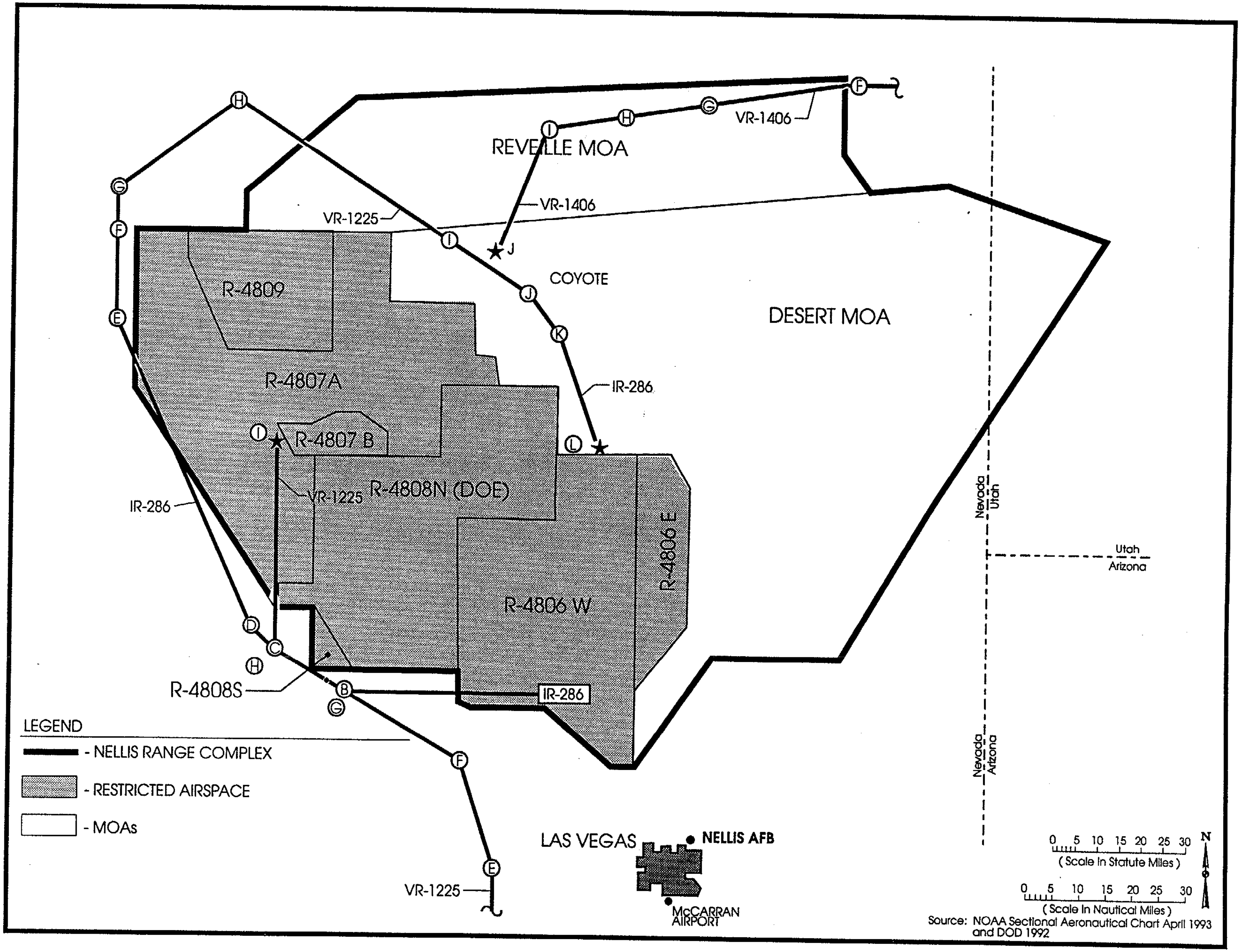


Figure 3-8. Military Training Routes VR-1406, VR-1225, and IR-286.

Table 3-10

MTR Noise Levels (L_{dnmr})

MTR	LEG	Sound Level for Various Lateral Distances (dB)				
		0 Ft	5,000 Ft	10,000 Ft	15,000 Ft	20,000 Ft
VR-1225	A-D	62	61	59	57	53
	D-E	62	61	59	57	53
	E-H	62	61	59	57	53
	H-I	61	60	58	56	52
VR-1406	A-J	48	48	46	44	40
IR-286	A-B	27	27	26	25	24
	B-D	54	54	52	49	46
	D-E	52	52	51	50	49
	E-M	55	55	53	50	47

Ft = feet
VR = visual route
IR = instrument route

Source: Frampton et al. 1993a

3.3.6 Processing of Data

During the maintenance of the Boom Event Analyzer Recorder (BEAR) noise monitoring units, data were collected, qualified, reduced, and analyzed. Measured sonic booms were coordinated with scheduled flights. Data obtained from each sonic boom were reduced to obtain peak overpressure, duration, site number, time, date, and other supporting information. A sequential database of booms was prepared for each site. This database enabled statistical analysis of individual and cumulative boom impact.

The collected information was combined with the airspace activity database to develop a master timeline of activity and booms within the Elgin subdivision. This timeline was used to identify sonic booms associated with ACM training. ACMI data was obtained for 20 percent of ACM sorties. Total ACM operations and those equipped with ACMI are summarized in Table 3-11.

Table 3-11

Aircraft Operations in the Elgin Subdivision

Aircraft Type	ACM Sorties	ACMI Sorties	% of Total ACMI Sorties
F-111	33	0	0
F-18	509	66	5
F-16	3,101	447	37
F-15	2,333	690	57
F-14	18	0	0
F-5	2	2	>1
F-4	2	0	0
Other	227	0	0
Total	6,225	1,205	100

The boom prediction by BooMap3 is sensitive to atmospheric conditions. Atmospheric data during the noise monitoring period were obtained from the National Oceanic and Atmospheric Administration (NOAA). The data were collected twice daily at 0300 and 1500 from NOAA radiosonde balloons, launched from Mercury, Nevada, which is on the southern edge of the Nellis Range Complex. Information collected included temperature, pressure, wind, and humidity as a function of altitude.

A total of 1,337 sonic boom records were obtained during the six-month monitoring period. It was common for a single sonic boom to be recorded on more than one BEAR. Grouping these boom records together yielded a total of 609 individual boom events. Of the 609 boom events, 584 correlated with scheduled ACM missions. The remaining 25 boom events were either unscheduled ACM or associated with other mission types. The 584 ACM boom events represented 0.1 boom per sortie. Table 3-8 (shown previously) contains a list of recorded boom statistics for each site, including days of operation, booms recorded, number of acoustical day and night booms, maximum and average boom overpressure, number of booms greater than 5 psf overpressure, maximum and energy average of peak level, maximum and energy average of the CSEL, and total L_{Cdn}. Booms greater than 5 psf and the recording site were listed previously in Table 3-9.

Of the 1,337 sonic boom records, 62 occurred during acoustical night (between 2200 and 0700). Eighteen (18) booms had peak overpressures greater than 5 psf. The average boom overpressure was 0.93 psf. The cumulative distribution of booms, i.e., the percentage of booms which exceeded various overpressures, is shown on a linear scale in Figure 3-9 and on a logarithmic scale in Figure 3-10. The L_{Cdn} noise contours compiled from the measured sonic booms were illustrated previously in Figure 3-6.

ACMI data were obtained for approximately 20 percent of total scheduled ACM sorties. Various statistical analyses were performed. Distributions of altitude and Mach number were found to be consistent with previous analyses of ACMI data in other ACM arenas. Total supersonic time was about 6 percent of range time, a value consistent with previous studies. No substantive differences were found between various aircraft types. It was also found that the number of booms per sortie for ACMI equipped aircraft was approximately the same as for all ACM sorties, so that the ACMI data provide a valid sampling of airspace use. A complete discussion of this analysis may be found in the sonic boom monitoring report (Frampton et al. 1993b).

3.3.7 Nellis Range Complex Operation

Numerous USAF and other service aircraft operate within the Nellis Range Complex on a regular basis, participating in various combat-readiness training exercises. Noise levels in the Nellis Range Complex associated with subsonic flight (the predominant condition outside of the ACM arena) have been analyzed. A complete subsonic noise report has been prepared (Frampton et al. 1993a). A summary is presented in the following.

The composite Nellis Range Complex noise levels were calculated using current USAF's NOISEMAP technology in conjunction with Nellis AFB operations information. The operations information used included RFMDS tracking data, ACMI tracking data, and Nellis AFB Range Control Group scheduling records. The operations were reduced to a common database and joined with ROUTEMAP and NOISEMAP computer models to calculate the noise environment and produce L_{dn} contours for the Nellis Range Complex.

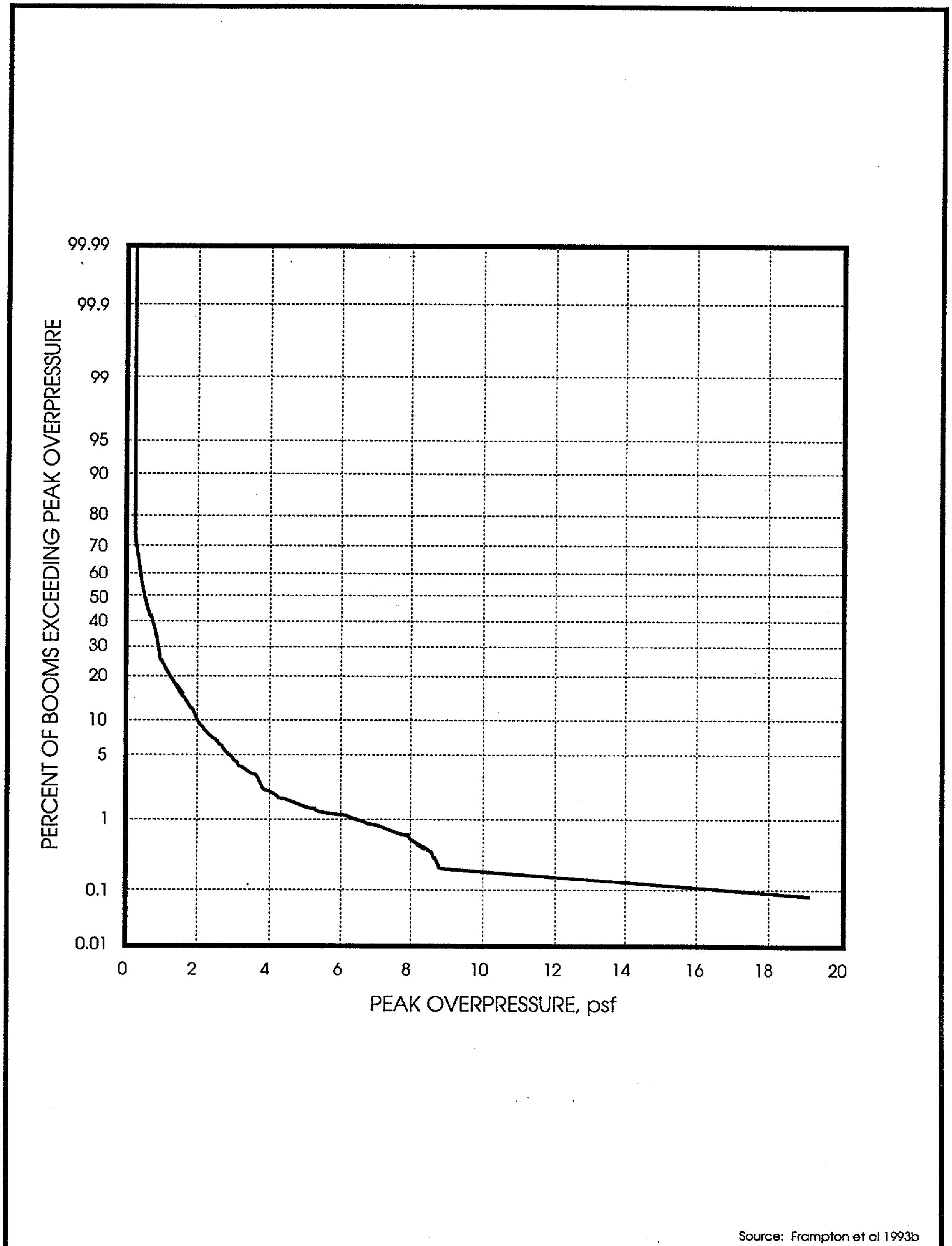


Figure 3-9. Overpressure Cumulative Probability Distribution (Linear Scale).

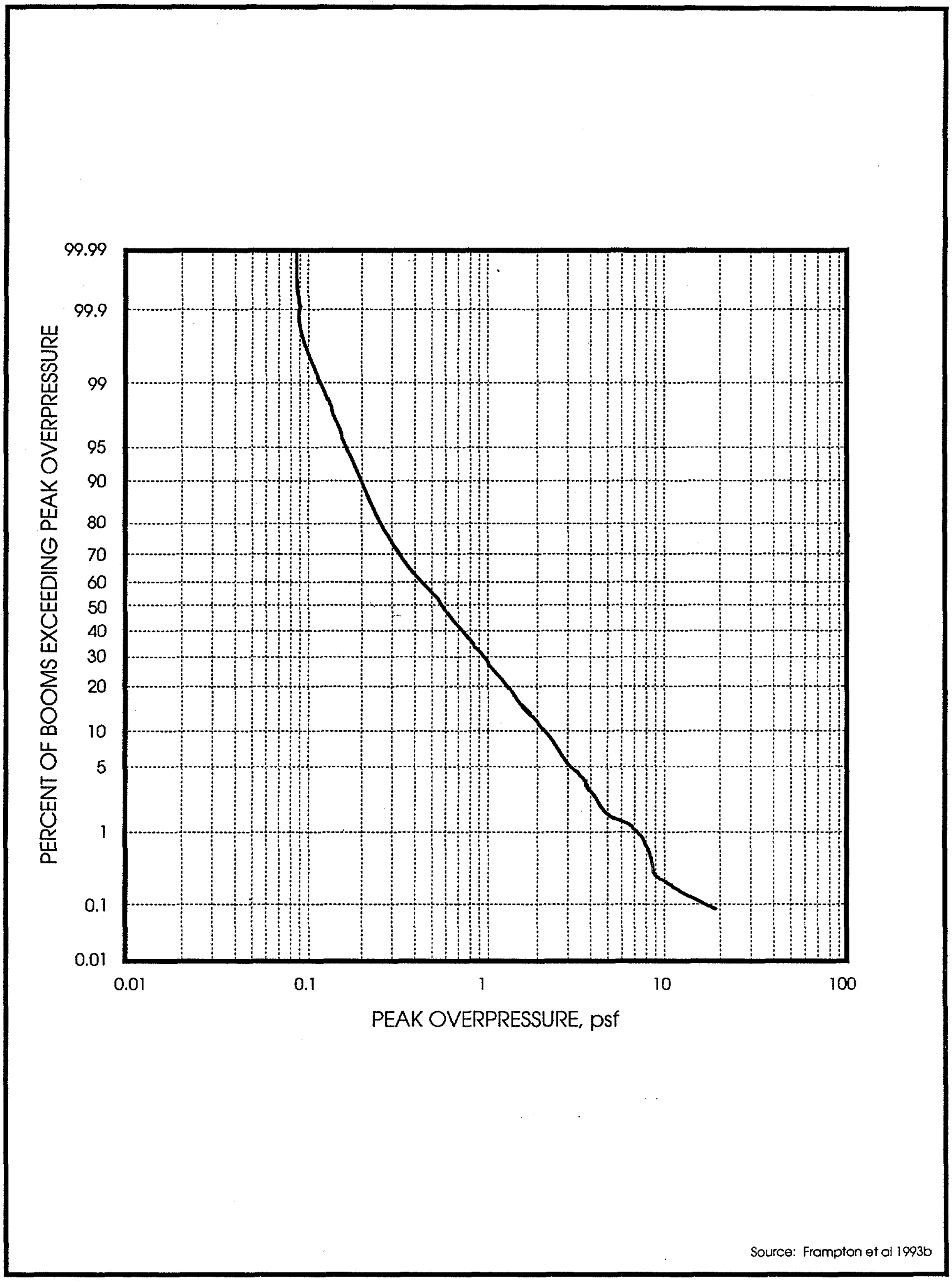


Figure 3-10. Overpressure Cumulative Probability Distribution (Logarithmic Scale).

Four operations training scenarios were analyzed. These scenarios included two Red Flag exercises, a Green Flag exercise, and ACMI tracking data. The range subdivisions used for the Red Flag tracking system include:

Reveille MOA	ECR East
Caliente Subdivision	Range 76
Coyote Subdivision	ECR South
Range 71	ECR West
Range 74	Pahute
Range 75	Range 4808W

These subdivisions of the Nellis Range Complex are collectively referred to as the RFMDS arena. The ACMI arena is in the Elgin and Caliente subdivisions of the Desert MOA. The remaining subdivisions of the Nellis Range Complex are:

Range 61	Range 64
Range 62	Range 65
Range 63	Alamo Subdivision

Within R-4808E, no flight activity is normally scheduled. The land below R-4808E airspace is the Groom Mountain Area.

Flight operations data were obtained from the Range Group for the period of May 1990 through June 1991 and March 1992 through September 1992. As a worst-case scenario, the busiest month of the 1992 schedule period (April) was selected for the Nellis Range Complex noise study. The flight operations, by aircraft type, for the month of April 1992 are shown in Table 3-12.

Of the total 3,385 sorties, approximately 96 percent were flown during acoustic daylight hours (0700 to 2200). Three aircraft types, F-18, F-16, and F-15, conduct the majority of sorties (approximately 80 percent) in the Nellis Range Complex.

Table 3-12

Range Group Schedule, April 1992

Aircraft	RFMDS		ACMI		Others		Total	
	Day	Night	Day	Night	Day	Night	Day	Night
F-111	56	0	0	0	0	0	56	0
F-18	275	8	153	0	2	0	430	8
F-16	325	28	524	12	417	22	1,266	62
F-15	449	32	322	4	146	6	917	42
F-14	55	8	0	0	14	0	69	8
F-5	12	2	0	0	0	0	12	2
F-4	84	0	2	0	3	0	89	0
A-10	40	0	4	0	223	0	267	0
A-6	38	8	20	0	8	0	66	8
B-2	0	9	0	0	0	9	0	18
Other	50	3	12	0	0	0	62	3
Total	1,384	98	1,037	16	813	37	3,234	151

(Operating Arena: RFMDS, ACMI, Others)

In addition to the MOAs and restricted ranges, the Nellis Range Complex also contains three MTRs. The locations of these routes were previously shown in Figure 3-8. The three MTR's flight operations data were obtained from the 57th FG stationed at Nellis AFB. As a worst-case scenario, the month with the highest number of scheduled operations for each MTR was selected for noise modeling. The month of October 1990 was selected for Visual Route 1225 (VR-1225) and VR-1406 and November 1990 for Instrument Route 286 (IR-286). The scheduled flights, by aircraft for these MTRs, are listed in Table 3-13.

Using the data obtained from the Range Group, RFMDS, and ACMI, the existing composite noise contours for the Nellis Range Complex MTRs were calculated (see Figure 3-7). The maximum existing L_{dn} calculated for Nellis Range Complex MTRs is 60 dB. Existing noise levels for the three MTRs were previously listed in Table 3-10, for each leg of the MTR, and various lateral distances from the centerline of MTR.

Table 3-13

MTR Flight Operations
(Busiest Month)

	MTR Monthly Operations		
Aircraft	VR-1225	IR-286	VR-1406
F-111	4	4	1
F-18	0	4	0
F-16	24	4	0
F-15	48	2	2
AV-8	1	9	0
A-7	1	0	1
T-38	0	3	0
Total	78	26	4

Source: Frampton et al. 1993a

3.4 Biological Resources

3.4.1 Ecosystem Setting and Vegetation

The Nellis Range Complex lies within the Great Basin and Mojave Deserts, which are part of the Basin and Range physiographic province. Climate, topography, geology, and soils typically are representative of arid regions within the Basin and Range province of the southwestern United States. Annual daytime temperature ranges from 60°F to over 100°F with clear skies, low humidity, and relatively low and extremely unpredictable precipitation. Topographical features of the Nellis Range Complex consist of elongated north-south mountain ranges separated by wide valleys or basins. The entire Nellis Range Complex is underlain by a wide variety of rocks ranging from Precambrian to Quaternary times. Alluvium and volcanics exclusively cover the northwestern portion, while the remainder of the Nellis Range Complex and the Nevada Nuclear Test Site have a variety of outcropping formations. Soil associations on the Nellis Range Complex consist of the St. Thomas series on the hills and mountains; Crosgrain and Arizo series on fans, and Mazuma and Ragtown series on the basin floor (BLM/DOI/USAF 1979; Clark 1979; Nevada Weather Bureau 1993; USDA 1993).

In the Basin and Range topography of the western United States the pattern of desertscrub vegetation of the valleys is well defined and repeated from basin to basin. In the southern part of the Mojave Desert, the alluvial fans are dominated by creosotebush communities. These communities are replaced by sagebrush and shadscale vegetation of the Great Basin Desert along an irregular boundary across southern Nevada. Since vegetation is not subject to impacts due to supersonic flight, it is not discussed in detail herein.

3.4.2 Wildlife

Vegetation diversity of the Great Basin and Mojave Deserts provides a diversity of habitat which creates varied and locally abundant animal communities within the Nellis Range Complex. The most common large mammals found in the Nellis Range Complex are the wild horse (*Equus caballus*), wild burro (*E. asinus*), mule deer (*Odocoileus hemionus*), desert bighorn (*Ovis canadensis nelsoni*), American pronghorn (*Antilocapra americana*), mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), kit fox (*Vulpes velox*), badger (*Taxidea taxus*), jackrabbit (*Lepus* spp.), and western spotted skunk (*Spilogale gracilis*).

Common small mammals (rodents) in the region are the Belding ground squirrel (*Spermophilus beldingi*), Townsend ground squirrel (*S. townsendii*), Merriam's kangaroo rat (*Dipodomys merriami*), long-tailed pocket mouse (*Chaetodipus formosus*), kangaroo rat (*Dipodomys* spp.), pocket mice (*Perognathus* spp.), antelope ground squirrel (*Ammospermophilus* sp.), and woodrats (*Neotoma* spp.).

3.4.2.1 Great Basin Desert

The Great Basin desertscrub area occurs in the northern portion of the Nellis Range Complex and is characterized by a distinct group of animals. Rodents commonly found in the different vegetation communities include dark kangaroo mouse (*Microdipodops megacephalus*) and sagebrush vole (*Lagurus curtatus*) found in the sagebrush community, and pallid kangaroo mouse (*Microdipodops pallidus*) and chisel-toothed kangaroo rat (*Dipodomys microps*) in the saltbush and other desertscrub plant series. Merriam's shrew (*Sorex merriami*) and montane vole (*Microtus montanus*) are more commonly found in the higher altitudes of the Nellis Range Complex. A number of mammals, such as the coyote and black-tailed jackrabbit (*Lepus californicus*), is found throughout the area (Turner 1982).

Large ungulates do not have large populations in the Great Basin Desert and are represented by the transient American pronghorn and desert bighorn sheep. Both species can occur throughout the Nellis Range Complex where suitable habitat is available, but are not common in the northern portion of the Nellis Range Complex.

Raptors are numerous both in terms of individuals and species. Other types of birds are not common in the desertscrub community due to the low-lying vegetation and limited supply of consumable seeds. Birds characteristic of sagebrush communities include sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), and sage grouse (*Centrocercus urophasianus*). Chukar partridge (*Alectoris chukar*) has been successfully introduced and established mainly in rocky precipitous habitats within the desertscrub community (MacMahon 1990; Turner 1982).

Due to cold winters, reptiles are not as abundant in the Great Basin Desert of the northern portion of the Nellis Range Complex as in the warmer Mojave Desert of the southern portion of the Nellis Range Complex. Common species include various lizards: sagebrush lizard (*Sceloporus graciosus*), leopard lizard (*Crotaphytus wislizenii*), collared lizard (*C. collaris*), northern side-blotched lizard (*Uta stansburiana*), and western and northern whiptails (*Cnemidophorus tigris tigris* and *C. tigris septentrionalis*, respectively). Common snakes include wandering garter snake (*Thamnophis elegans vagrans*) and the Great Basin and Hopi rattlesnakes (*Crotalus viridis luteosus* and *C. viridis nuntius*, respectively) (Turner 1982).

3.4.2.2 Mojave Desert

The Mojave Desert area occurs in the southern portion of the Nellis Range Complex. There are few large mammals in this desert region due to the sparse vegetation. Principal large species are desert bighorn sheep and coyote. Blackbrush communities, with associated grama grass on the upper alluvial fans at elevations of 4,200 to 6,000 feet above MSL, are areas of heavy utilization and preferred habitat for desert bighorn sheep in southern Nevada. Mule deer and American pronghorn only occur near the periphery of the desert (Turner 1982). The introduced wild burro has destroyed much of the desert habitat and thus widely eliminated native desert bighorn sheep. The latest desert bighorn sheep count (1991) located approximately 260 animals on the DNWR. The total number of desert bighorn sheep has been declining since 1986, and it is estimated that 975 bighorn sheep now occur on the DNWR (DNWR 1993).

Smaller, less wide-ranging mammals are abundant in the Mojave desertscrub. Rodents characteristic of Mojave creosotebush communities include Merriam's kangaroo rat, little pocket mouse (*Perognathus longimembris*), whitetailed antelope squirrel (*Ammospermophilus leucurus*), desert woodrat (*Neotoma lepida*), southern grasshopper mouse (*Onychomys torridus*), long-tailed pocket mouse, and cactus mouse (*Peromyscus eremicus*).

Birds of the region include the prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), and bald eagle (*Haliaeetus leucocephalus*). The number of breeding bird species in the low shrub areas of the Mojave Desert is limited, while in areas with a greater vegetation diversity the number is greater. In deserts, trees or large cacti are the principal element of the increased number of bird species. Additionally, the presence of a large number of smaller plants (e.g., chollas) increases the number of species. For example, the cactus wren (*Campylorhynchus brunneicapillus*) is a species that often nests in cacti. Other Mojave Desert birds include phainopepla (*Phainopepla nitens*), loggerhead shrike (*Lanius ludovicianus*), Gambel's quail (*Callipepla gambelii*), mourning dove (*Zenaida macroura*), greater roadrunner (*Geococcyx californianus*), and common raven (*Corvus corax*) (MacMahon 1990).

Lizards which occur in the Mojave Desert include the desert night lizard (*Xantusia vigilis*), banded gecko (*Coleonyx variegatus*), chuckwalla (*Sauromalus obesus*), desert iguana (*Dipsosaurus dorsalis*), Mojave fringe-toed lizard (*Uta scoparia*), banded gila monster (*Heloderma suspectum cinctum*), desert side-blotched lizard (*Uta stansburiana stejnegeri*), regal horned lizard (*Phrynosoma solare*), southern desert horned lizard (*P. platyrhinos calidiarum*), and western whiptail (Turner 1982). The desert tortoise (*Gopherus agassizi*) is found in the Mojave Desert up to about 4,000 feet above MSL (Stebbins 1985).

Snakes are abundant in the Mojave Desert. Common species are: western leafnose snake (*Phyllorhynchus decurtatus perkinsi*), western blind snake (*Leptotyphlops humilis*), desert rosy boa (*Lichanura trivirgata gracia*), coachwhip (*Masticophis flagellum*), Mojave patchnose snake (*Salvadora hexalepis mojavensis*), Great Basin gopher snake (*Pituophis melanoleucus deserticola*), California kingsnake (*Lampropeltis getulus californiae*), western longnose snake (*Rhinocheilus lecontei lecontei*), western ground snake (*Sonora semiannulata*), Mojave shovelnose snake (*Chionactis occipitalis occipitalis*), desert night snake

(*Hypsiglena torquata deserticola*), Sonoran lyre snake (*Trimorphodon biscutatus lambda*), sidewinder (*Crotalus cerastes*), and Mojave rattlesnake (*C. scutulatus*) (Turner 1982).

3.4.3 Threatened/Endangered Species and Critical/Sensitive Habitats

3.4.3.1 Federal

The Endangered Species Act (ESA) of 1973 as amended was enacted to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. An endangered species is a species which is in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Proposed species are those which have been formally submitted to Congress for official listing as threatened or endangered. In addition, the USFWS has identified species that are candidates for listing as a result of identified threats to their continued existence. There are three candidate classification categories: (1) Candidate Category 1 includes those species for which the USFWS has sufficient information on hand to support their being listed as either endangered or threatened; (2) Candidate Category 2 includes those species for which the USFWS does not have sufficient information to support their being listed as threatened or endangered at this time; and (3) Candidate Category 3 contains species that are no longer being considered for listing as threatened or endangered because the species is extinct, the species is not regarded as taxonomically valid, or the species is more widespread or not subject to an identifiable threat.

The ESA also considers the conservation of a species in its critical habitat. Critical habitat is defined as certain known areas within the species' occupied range on which are found those physical or biological features (1) essential to the conservation of the species and (2) which may require special management consideration or protection and tracts outside of the species' currently occupied range that are essential for the conservation of the species. One of the primary threats to most species is the destruction or modification of essential habitat areas by uncontrolled land and water development.

A total of 27 federal endangered, threatened, and candidate species occurs within the Nellis Range Complex. Eight species are listed as endangered, five as threatened, one as proposed threatened, and 13 as Candidate Category 1 (Table 3-14). As of 1991, the USFWS list of endangered and threatened species indicated that 43 percent of the total number were wetland-dependent. Eight of the 27 wetland-dependent federally listed endangered/threatened species in Nevada are known to occur within the Nellis Range Complex (see Table 3-14) (Feierabend 1992; USFWS 1992b, 1994a, 1994b).

In 1984, Nevada Department of Wildlife began a reintroduction program for the peregrine falcons and have since released peregrines at the following sites: Ruby Lakes NWR (Ruby Mountains and East Humboldts), Las Vegas Hilton, and Snake Valley (southern Snake Range). There are two known active eyries in Nevada: (1) along cliffs downstream from Boulder Dam and (2) at Lake Mead National Recreation Area (NRA). Peregrine falcons are regularly sighted in the spring and fall at Stillwater NWR and Carson Lake. There is also evidence that peregrines may have historically nested in the south near the Colorado River. About 450 pairs are known to occur in the 12 western states, and about 720 pairs were estimated by state agencies in 1991. No peregrine falcons have been recorded as nesting at the Nellis Range Complex, but may occur as a transient to reintroduction sites northeast and southeast of the Nellis Range Complex (Hamlin 1993a).

Approximately 125 bald eagles winter in Nevada from November through March; approximately 60 percent in western Nevada, 35 percent in eastern Nevada, and 5 percent in the south. Key wintering areas identified in the Pacific states bald eagle recovery plan include: Lake Tahoe, Lake Mead NRA, Pahranagat NWR, White River Kirch Wildlife Management Area (WMA), Stillwater NWR, Lahontan Reservoir, Carson Valley/Mud Lake, Carson Lake, Antelope Valley, Ruby Lakes NWR, Ogder's Pond, and Salmon Falls Creek. Bald eagles winter on Pahranagat NWR and White River Kirch WMA, both located under the Desert MOA portion of the Nellis Range Complex. They may also occur as transients in other wintering areas located west, northeast, and southeast of the Nellis Range Complex (Hamlin 1993b).

Portions of the Nellis Range Complex have been surveyed since 1979 for the presence of listed and candidate plant species. These surveys have include the DNWR, R-4809 (Tonopah Test Range), Desert MOA (Groom Mountain Range), and R-4807 (North Range). In addition, surveys for Beatley's milkvetch (*Astragalus beatleyae*) have been conducted in selected areas of the North Range. In 1989, none of the 29 species surveyed during the preceding 10 years was formally listed as threatened or endangered; however, 17 species were candidates for listing with one species (Beatley's milkvetch)

Table 3-14

Threatened, Endangered, and Candidate Category One Species Potentially Occurring on the Nellis Range Complex

		Status		County	
Common Name	Scientific Name	Federal	State	Nevada	Utah
PLANTS					
Beatley milkvetch	*Astragalus beatleyae*	C1	CE	Nye	
Blue Diamond cholla	*Opuntia whipplei* var. *multigeniculata*	C1	CE#, CY	Clark, Nye	
Charleston kittentails	*Synthyris ranunculina*	C1		Clark	
Charleston tansy	*Sphaeromeria compacta*	C1		Clark	
Clokey eggvetch	*Astragalus oophorus* var. *clokeyanus*	C1		Clark	
Plateau lady's tresses	*Spiranthes diluvialis*	T	CE#	Lincoln	
Sodaville milkvetch	*Astragalus lentiginosus* var. *sesquimetralis*	PT	CE	Nye	
California bearpoppy	*Arctomecon californica*		CE	Clark	
Threecorner milkvetch	*Astragalus geyeri* var. *triquetrus*		CE	Clark	
Halfring milkvetch	*Astragalus mohavensis* var. *hemigyrus*		CE#	Clark	
Las Vegas cryptantha	*Cryptantha insolita*		CE	Clark	
Sticky buckwheat	*Eriogronum viscidulum*		CE	Clark	
Schlesser pincushion	*Sclerocactus schlesseri*		CY	Lincoln	
Ancient bristlecone pine	*Pinus longaeva*		CY	Nye, Clark	
Sunnyside green gentian	*Frasera gypiscola*		CE#	Nye	
Blaine pincushion	*Sclerocactus blainei*		CY	Nye	
Clokely pincushion	*Coryphantha vivpara* ssp. *rosea*		CY	Clark, Lincoln, Nye	
Sand cholla	*Opuntia pulchella*		CY	Lincoln, Nye	
Mojave fishhook cactus	*Sclerocactus polyancistrus*		CY	Nye	
Great Basin fishhook cactus	*Sclerocactus pubispinus* var. *pubispinus*		CY/S3	Lincoln, Nye	Iron
Mojave barrel cactus	*Ferocactus acanthodes* var. *lecontei*		CY	Lincoln, Nye, Clark	
Simpson hedgehog cactus	*Pediocactus simpsonii* var. *simpsonii*		CY	Nye	
Pinkegg milkvetch	*Astragalus oophorus* var. *lonchocalyx*		S1		Iron
INVERTEBRATES					
Crystal Spring pebblesnail	*Pyrgulopsis cristulis*	C1		Nye	
Distal-gland springsnail	*Pyrgulopsis nanus*	C1		Nye	
Elongate-gland springsnail	*Pyrgulopsis isolatus*	C1		Nye	
Fairbanks springsnail	*Pyrgulopsis fairbanksensis*	C1		Nye	
Median-gland Nevada springsnail	*Pyrgulopsis pisteri*	C1		Nye	
Sportinggoods tryonia snail	*Tryonia angulata*	C1		Nye	
Point of Rocks tryonia snail	*Tryonia elata*	C1		Nye	
Minute tryonia snail	*Tryonia ericae*	C1		Nye	

Table 3-14 (Continued)

Threatened, Endangered, and Candidate Category One Species Potentially Occurring on the Nellis Range Complex

Common Name	Scientific Name	Status Federal	Status State	County Nevada	County Utah
FISH					
Big Spring spinedace[1+]	*Lepidomeda mollispinis pratensis*	T	P	Lincoln	
Hiko White River springfish[2+]	*Crenichthys baileyi grandis*	E		Lincoln	
Moapa dace[+]	*Moapa coriacea*	E	E	Clark	
Pahranagat roundtail chub[+]	*Gila robusta jordani*	E	E	Lincoln	
Pahrump poolfish[+]	*Empetrichthys latos*	E	E	Clark	
Railroad Valley springfish[3+]	*Crenichthys nevadae*	T	P	Nye	
White River spinedace[4+]	*Lepidomeda albivallis*	E	P	Nye	
White River springfish[5+]	*Crenichthys baileyi baileyi*	E		Lincoln	
REPTILES					
Desert tortoise[6]	*Gopherus agassizi*	T	T	Clark	Washington
BIRDS					
American peregrine falcon	*Falco peregrinus anatum*	E	E	Clark, Nye, Lincoln	Iron
Bald eagle[+]	*Haliaeetus leucocephalus*	T	E	Clark, Nye, Lincoln	Iron
Mexican spotted owl	*Strix occidentalis lucida*	T	T		Iron, Washington
MAMMALS					
Utah prairie dog	*Cynomys parvidens*		T		Iron, Washington

[+] Wetland-dependent species
[1] Designated critical habitat in Condor Canyon (Meadow Valley Wash), Lincoln County
[2] Designated critical habitat in Hiko Spring and associated outflows in Lincoln County
[3] Designated critical habitat in Duckwater Area (Big Warm Spring and its outflow pools, streams, and marshes and 50 ft. riparian zone) and Lockes Area (North, Hay Corral, Big, and Reynolds Springs and their outflow pools, streams, and marshes and 50 ft. riparian zone) in Nye County
[4] Designated critical habitat in Flag Springs and associated outflows in Nye County
[5] Designated critical habitat in Ash Springs and associated outflows in Lincoln County
[6] Designated critical habitat in the Gold Butte-Pakoon Unit, Clark County

Legend:
- E = Endangered
- T = Threatened
- PT = Proposed Threatened
- C1 = Candidate Category One
- P = Protected
- var. = variety
- CE = Critically Endangered (Nevada Plant Classification)
- CE# = Recommended for Listing as Critically Endangered (Nevada Plant Classification)
- CY = Protected as Cactus, Yucca, or Christmas Tree (Nevada Plant Classification)
- S1 = Critically Endangered throughout Range (Utah Plant Classification)
- S3 = Threatened throughout Range (Utah Plant Classification)
- ssp. = subspecies

Source: Atwood et al. 1991; Feierabend 1992; USFWS 1992b, 1994a, 1994b, 1994c, 1994d; Morefield and Knight 1992; Nevada Department of Wildlife 1994; Utah Division of Wildlife Resources 1994; Utah Natural Heritage Program 1994 attaining Candidate Category 1 status and the remaining 16 species Candidate Category 2 status (SAIC 1991).

Southern Nevada provides habitat for many endemic species in the isolated springs of the Pahranagat and Moapa NWRs, both located under the Desert MOA portion of the Nellis Range Complex. These refuges contain a high concentration of unique organisms which have evolved in isolation over the last few thousand years. Twelve species of threatened and endangered fish are in the area where supersonic flights occur. The ranges of eight of these species (see Table 3-14) are located entirely under the Desert MOA, while the remaining four species are found southwest of the Nellis Range Complex (SAIC 1991; WWF 1990, 1992).

3.4.3.2 Critical Habitats

Six critical habitats have been federally designated by USFWS within the Nellis Range Complex. These critical habitats include habitat for five fish species (three in Lincoln County and two in Nye County) located in various springs and their associated outflows under the Desert MOA, and habitat for one reptile in Clark County (see Table 3-14) (USFWS 1994a, 1994c).

3.4.3.3 State

The states of Nevada and Utah classify endangered and threatened species differently than the federal government. Fish and wildlife species listed by the Nevada Department of Wildlife are all Protected (P) with some of these protected species being further classified as Sensitive (S), Threatened (T), or Endangered (E). The State of Nevada also provides protection to rare and sensitive plant species, particularly those endemic to Nevada. The classification which most closely resembles that of the USFWS is the status of Critically Endangered (CE). Critically Endangered species are those taxa threatened with extinction and whose survival requires assistance due to overexploitation, habitat destruction, and/or disease. Species may also be recommended for listing as critically endangered, pending formal listing (CE#), or protected (CY) as a cactus, yucca, or Christmas tree (Morefield and Knight 1992; Nevada Department of Wildlife 1994).

The State of Utah Division of Wildlife Resources lists native Utah wildlife species of special concern as Endangered (E), Threatened (T), and Sensitive (S). Plant species are classified as critically endangered throughout range (S1), endangered throughout range (S2), or threatened throughout range (S3) (Atwood et al. 1991; Utah Division of Wildlife Resources 1994; Utah Natural Heritage Program 1994).

A total of 31 state endangered, threatened, and protected species occurs within the Nellis Range Complex. The State of Nevada lists six critically endangered, four recommended for listing as critically endangered, and 10 protected plant species as well as five endangered, one threatened, and three protected wildlife species. One critically endangered and one threatened plant species along with three threatened wildlife species are listed by the State of Utah (see Table 3-14) (Morefield and Knight 1992; Nevada Department of Wildlife 1994; Utah Division of Wildlife Resources 1994; Utah Natural Heritage Program 1994).

3.4.3.4 Sensitive Habitats

There are various springs and natural, as well as man-made, water encatchments on the Nellis Range Complex. Surface water consists of two small water bodies, Lower Pahranagat Lake and Crystal Spring Lake, which are located under the Desert MOA. Six sensitive wetlands sites are listed by the USFWS and the State of Nevada as occurring under the Desert MOA within the Nellis Range Complex: Railroad Valley/Duckwater, White River Kirch WMA, Pahranagat/Key Pittman WMA, Spring Valley, Meadow Valley Wash, and Muddy River/Warm Springs (Nevada Department of Conservation and Natural Resources 1988; USFWS 1990).

3.5 Cultural Resources

3.5.1 Introduction

The airspace of the Nellis Range Complex covers a large area of southwestern Nevada, north of the City of Las Vegas. The land comprising the Nellis Range Complex is located primarily in the southwestern portion of the Great Basin region lying along the southeastern/southwestern cultural zone interface (Fowler and Madsen 1986; Warren and Crabtree 1986). The highly diverse environment encompassed by the Nellis Range Complex includes numerous floral, faunal, geological, and mineral resources that have attracted both prehistoric and historic populations to the area during the last 12,000 years, therefore resulting in a vast number and variety of cultural resource properties.

3.5.2 Archeological and Historical Background

The earliest groups known to have frequented this area are small groups of nomadic hunter-gatherers known as Paleo-Indians. The apparent availability of big game and aquatic resources around the lakes within the Great Basin about 12,000 to 10,000 years B.C. attracted these people. The presence of these groups has been acknowledged through their projectile point assemblages characterized by a widespread "fluted" tradition. The southwestern area exhibits the Lake Mojave and Parmen points (leaf-shaped, long stemmed points with narrow shoulders) in addition to the fluted Clovis points of this period.

As the environment changed at the end of the Pleistocene, so did adaptation strategies by man in the area. Although hunting and gathering was still the main source of food procurement, hard seed and root processing also developed. This change is evidenced by the more abundant number of basin-shaped, ground milling stones and small ground hand stones. These processing tools indicate more dependence on the gathering of vegetal foodstuffs than in the prior period. This strategy reflects the fluctuations in the availability of food resources in the Great Basin at this time. This period is known as the Archaic, and more specifically the Western Archaic. In the southwestern area of the Great Basin, the Archaic period is further divided into sub-periods: Lake Mojave, Pinto, and Gypsum. In the southeastern area of the Great Basin, this period is broadly defined as the Archaic and Horticultural periods. In both areas, the southeastern area in particular, interaction with Anasazi groups to the east (the geographical and cultural Southwest of the United States) is evidenced through assemblages (e.g., pottery types) and architectural remains. Some other important aspects appearing late in this period are the growing of cultigens, use of more masonry storage and living structures, split-twig figurines, and the introduction and widespread use of the bow and arrow.

The later prehistoric period is known as the Shoshonean period and covers ca. A.D. 1200 to contact with Europeans. A hunting and gathering subsistence base continued into this period, although horticulture practices were also apparent. Crude brown pottery and small side-notched points characterize this tradition. Although the Shoshone and Piaute people living in this portion of the Great Basin by the time of contact were familiar with horses, it was not until the mid-seventeenth century that full utilization of the horse was realized. When not used for transportation or as a pack animal, the horse became a food source.

The Great Basin was probably first visited by the Spanish in the late eighteenth century with expeditions into the southeastern portion looking for an overland route from Santa Fe to Alta, California. The Spanish lost all its territory in North America to the Mexican government in 1821. British and American interest grew and they took full advantage of this change in control by sending more trappers, traders, and explorers into the previously unknown interior of the Great Basin. By the mid-1840s, the Americans had control of the land and migration into the area was extensive. The local Shoshone, Piaute, and Ute groups were forced into conflicts with the Euro-Americans arriving because of the competition for the sparsely available resources. The remaining Native Americans were placed onto reservations by the late 1800s. During this time large mining operations began to appear with the discovery of silver and other minerals in this area of Nevada. Soon large ranches were also being established throughout the southern Great Basin by Euro-Americans. Much of modern Nevada derived from the establishment of these early mining and ranching communities. In the late 1930s, the federal government began to acquire the land for what was to eventually become the Nellis Range Complex which was established in 1942.

3.5.3 Known Cultural Resource Properties

Due to a long period of human use of the region, cultural resource properties may be found in most environmental niches. However, due to the extreme variability in resource abundance, the spatial distribution and density of sites varies significantly. A sample survey of the Tonopah Testing Range and Nellis Range Complex area conducted by Bergin (1979) indicated that site densities range from 16 sites per square mile near water resources to 2.6 sites per square mile along the dry lake terraces.

Over 1,900 cultural properties have been recorded on the Nellis Range Complex, including the Tonopah Test Range R-4809, but excluding the DOE Nevada Nuclear Test Site R-4808 (SAIC 1991). The Nevada Nuclear Test Site has approximately 2,008 recorded sites. These sites vary in type, age, and condition and date to both the prehistoric and historic periods. Prehistoric sites are comprised of lithic scatters, toolstone quarries, open temporary camps, temporary camps in rock shelters, limited activity localities, petroglyph localities/panels, and isolated artifacts. The Pintwater Cave and the Tim Spring petroglyph sites, located in the northwest corner of Clark County near locations of typical supersonic flights within

R-4806 of the Nellis Range Complex, are listed on the National Register of Historic Places. Historic sites include mining camps, localities and districts, boom towns, ranches, and homesteads. Other resources such as cliff dwellings, historic pueblos, and ranching adobe-style huts may still exist but are yet undiscovered within the boundaries of Nellis Range Complex.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Proposed Action

4.1.1 Land Use

The proposed action would not result in a change or alter the land use in Nellis Range Complex. Existing land use in the area is compatible with supersonic flight. Supersonic flight activity would have the potential to adversely affect scenic and wilderness values of the existing WRAs and WMAs. However, the proposed action is not expected to increase the number or frequency of supersonic flights over these areas and impacts on scenic and wilderness values would not be expected as a result of the proposed action.

4.1.2 Air Quality

4.1.2.1 Proposed Action Emissions

Under the proposed action, supersonic operations would continue as currently conducted at the Nellis Range Complex; therefore, emissions would remain at the current levels (see Table 3-7). Because these emissions were spread over the entire 20,710 square miles of the Nellis Range Complex and were insignificant, impacts from aircraft sorties under the proposed action would be insignificant.

4.1.2.2 Conformity Determination

According to 49 CFR 51.853.c.2.ii, continuing and recurring activities, where the activities conducted are similar in scope and nature to activities currently being conducted, are granted an exemption from the requirement to prepare a conformity determination. Since the proposed action is the continued supersonic use of the Nellis Range Complex and the supersonic usage is not expected to increase, the proposed action would be in conformity with the current SIP and would exempt from requirements to prepare a conformity determination.

4.1.3 Noise

4.1.3.1 Noise Environment of Proposed Action

The proposed action is to continue supersonic flights in the same manner as previously conducted. The sonic boom and noise environment would therefore be as depicted in Section 3.3. In summary, the sonic boom environment consists of the following:

- The cumulative sonic boom exposure in the center of the Elgin subdivision of the Desert MOA would have L_{Cdn} in the range of 55 to 60 dB. L_{Cdn} elsewhere would be below 50 dB.
- The average sonic boom overpressure is just under 1 psf. At the center of Elgin subdivision, booms may be heard at an average of somewhat less than once per day. In other parts of the Nellis Range Complex with supersonic flight activity, booms may be heard at an average of once or twice a week.
- A small percentage of booms, 1.3 percent, has amplitude in excess of 5 psf. Such booms would be noticeable but rare, occurring at a given location at a rate of once or twice a year. As long as the 5,000-foot AGL floor is observed, booms are not expected to exceed about 10 psf.
- During the monitoring study, one 20 psf boom was measured. This boom was apparently due to an aircraft below the 5,000-foot AGL floor. While it is difficult to base meaningful statistics on a single data point, it is estimated that such an event would occur once every several years.

4.1.3.2 Effect on Humans

The predominant effect of sonic booms on humans is annoyance. Figure 4-1 shows the relationship between L_{Cdn} and annoyance. This curve is based on data presented in a study of impulsive noise by the National Research Council (CHABA 1981). A similar curve for annoyance by conventional aircraft noise is also shown in Figure 4-1 (Schultz 1978). The maximum L_{Cdn} values for sonic booms and the maximum L_{dn} values presented for subsonic noise both fall in the range of less than 10 percent annoyance. Over most of the Nellis Range Complex, where levels are lower, annoyance is expected to be less than 5 percent.

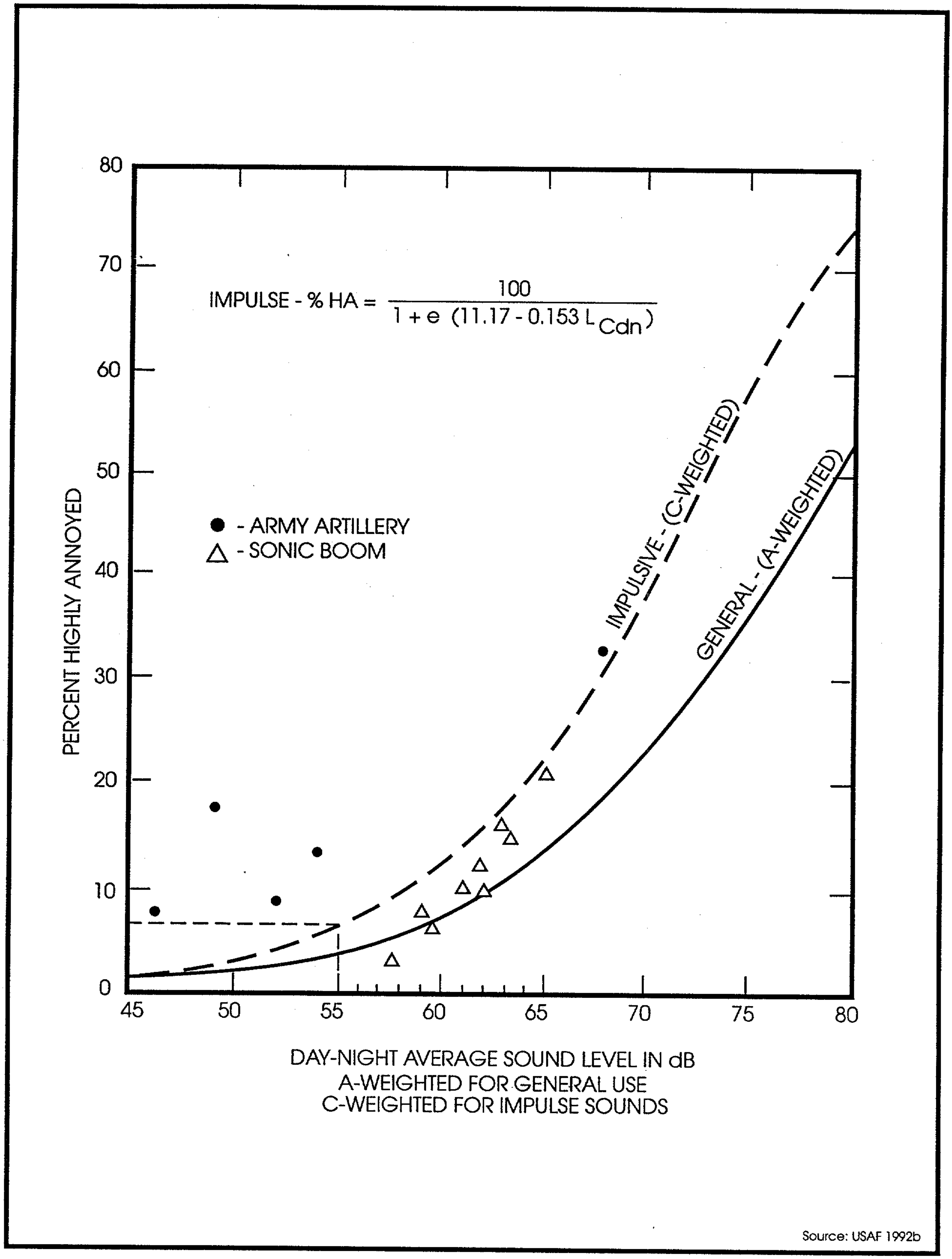


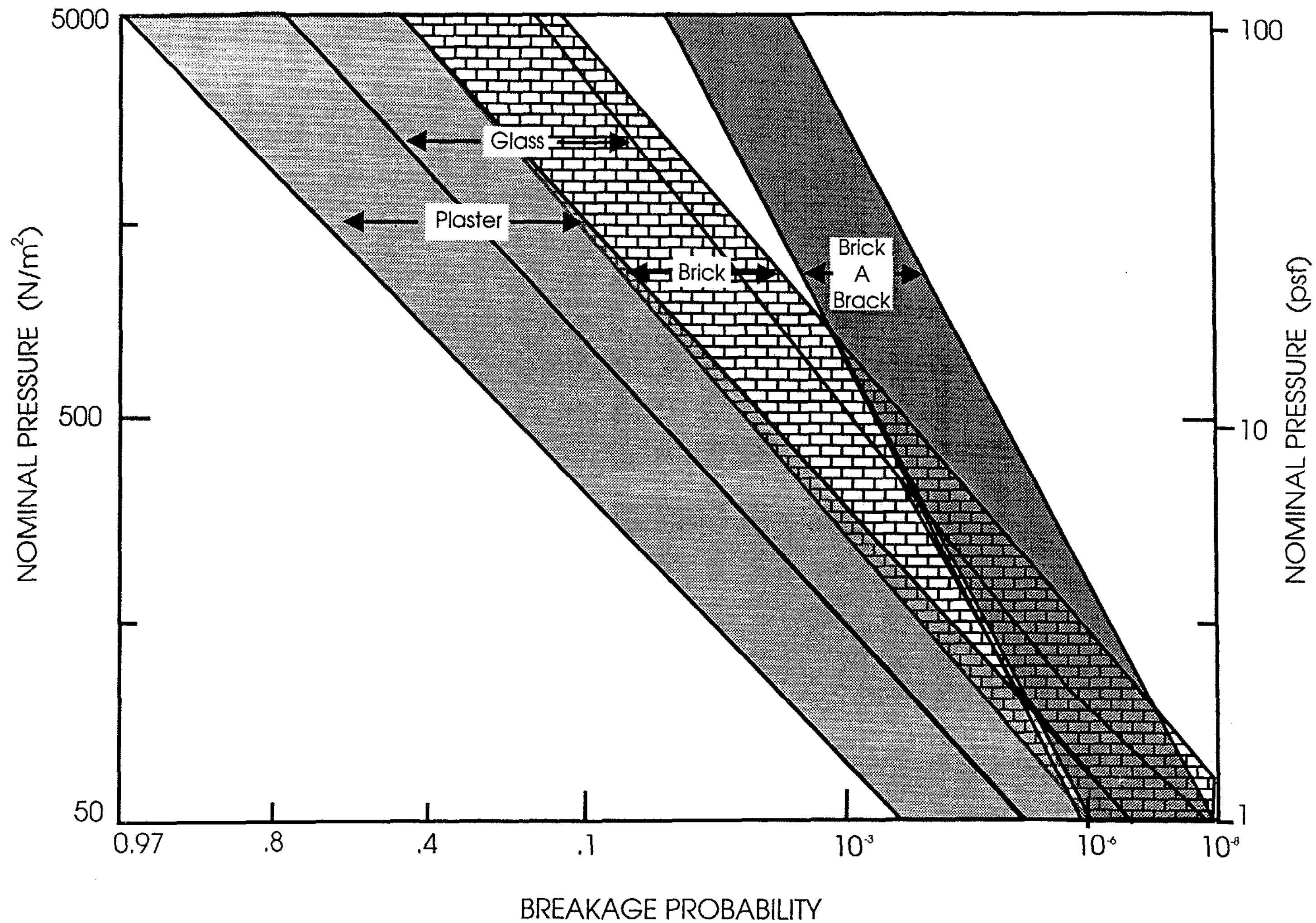
Figure 4-1. Relationship Between Annoyance and Cumulative Exposure to Noise and Sonic Booms.

While there would be some annoyance due to sonic booms, the individual booms are not of a level which would cause any direct physiological or hearing damage. Ninety-eight percent of the booms have peak levels below the 140 dB limit specified by the Occupational Safety and Health Act for impulsive noises in the workplace. That occupational limit is established for protection of workers who are continuously exposed to such noises over a working career. An occasional event above that level would not cause any hearing damage. No auditory damage occurred in a group of subjects exposed to a series of booms from 50 to 144 psf (Nixon et al. 1968).. Since hearing loss, if any, tends to precede other physiological effects of noise, it is not surprising that no other adverse health effects were observed in those tests either. Sonic booms also do not appear to have any cumulative long-term health effects. An epidemiological study conducted in the Desert MOA (the sonic boom environment currently being analyzed) failed to detect any such effects.

It is worth noting that the amplitude of the two anomalously highest booms measured (one at 11 psf and one at 20 psf) falls in a range comparable to the measured amplitude of aerial bursts of fireworks (Maglieri and Henderson 1973). While rare (projected to occur only once every few years) and not damaging, such a boom reaching a populated area of the range would be very annoying to the individuals affected. The 5,000-foot AGL minimum altitude restriction for supersonic flight must be adhered to.

4.1.3.3 Effects on Structures

An expected effect of sonic booms is the capability to cause structural damage, particularly to brittle materials such as glass or plaster. Figure 4-2 summarizes the probability of damaging different types of brittle materials (Hershey and Higgins 1976). The average boom of 1 psf has very little chance of damage, about one-in-a-million of breaking a window. Laboratory studies have shown that properly installed glass in good condition does not break at pressures less than 10 psf (White 1972). A boom amplitude of 11 psf has been identified as the threshold of expected structural damage (Clarkson and Mayes 1972). A recent study of unconventional structures indicates that the probabilities of damaging other types of structures (e.g., adobe walls, utility buildings, archeological sites) are less than the probability of glass breakage (Sutherland et al. 1990). It is thus expected that significant structural damage would not occur.



Source: Hershey and Higgins 1976

Figure 4-2. Damage Predictions for Four Kinds of Construction Materials.

Despite the expectation that the threshold of structural damage is around 10 or 11 psf, there is a finite probability of damage at lower levels. Even though the probability is very small, windows do break and plaster can crack at relatively low boom overpressures. It is USAF policy at Nellis AFB, as well as other ranges, to make restitution for sonic boom damage claims that are physically credible, even if of low probability. As long as boom amplitudes remain at current levels, minor damage would remain relatively infrequent and would continue to be managed by prompt settlement of claims.

4.1.3.4 Effects on Wild and Domestic Animals

The effect of sonic booms on animals has been a controversial subject. Several anecdotal accounts have suggested significant adverse effects. However, recent studies have failed to reproduce these effects, and indicate that sonic booms at levels not harmful to humans tend to have relatively small effects on animals. Good reviews of the literature are presented by Kull and Fisher (1986) and Dufour (1980).

Generally, birds tend to react more than farm animals to sonic booms. But this reaction tends to be non-intrusive. The response of eight species of raptors to over 100 sonic booms and 1,000 overflights was often minimal and never productivity-limiting (Ellis 1981). No effects were seen on the nesting cycle of birds in 301 monitored nests exposed to one to three booms per day. Lapwings were not observed to be disturbed by booms up to 18 psf, and pheasants were observed to not be adversely affected by 66 booms in a period of 72 days.

One of the most widely quoted adverse effects of sonic booms on birds was the mass hatch failure of sooty terns in the Dry Tortugas (Robertson 1970), which was speculatively blamed on unconfirmed sonic boom exposure. Recent laboratory experiments have shown that repeated high-amplitude sonic boom exposure does not adversely affect the hatch rate of bird eggs (Bowles et al. 1991). In addition to discounting physical damage to the eggs, the original observations indicated that the duration of fleeing behavior during panic flights was too short to account for damage.

Recent studies of mammals on USAF ranges have suggested that animals tend to habituate to sonic booms, and long-term effects are not adverse. These studies included physiological measurements of response (Bunch and Workman 1993) as well as behavioral observations. Claims in the 1960s that sonic booms adversely affected the reproductive cycle of captive mink have never been replicated in controlled experiments (Travis et al. 1972).

Overall, while studies are still in progress on the effects of sonic booms on animals, it appears that the sonic boom environment on the Nellis Range Complex, which is not hostile to humans, is also not hostile to animals. This is consistent with a suggestion by the National Research Council that noise levels which are protective of humans also protect domestic animals and wildlife (CHABA 1977).

4.1.4 Biological Resources

4.1.4.1 Vegetation

The proposed action does not involve activity on the ground, and thus would not have an impact on vegetation.

4.1.4.2 Wildlife

As discussed in Section 4.1.3.4, noise and sonic booms would not impact wildlife or domestic animals. Since the proposed action involves no ground-based activity, adverse impacts to wildlife would not occur.

4.1.4.3 Threatened/Endangered Species and Critical/Sensitive Habitats

- Vegetation

The proposed action does not involve activity on the ground and therefore would not have an impact on threatened/endangered plants.

- Wildlife

The endangered American peregrine falcon occurs as a transient species within the Nellis Range Complex. There are no known nesting sites and the potential for an aircraft collision is low; therefore, there would be no adverse impacts on the peregrine falcon. Two winter populations of the threatened bald eagle occur on Pahranagat NWR and White River Kirch WMA under the Desert MOA on the Nellis Range Complex. The Pahranagat NWR has supersonic flight restrictions, while the White River Kirch WMA has only flight restrictions (Table 4-1). Due to these specific flight restrictions, the bald eagle wintering areas would not be impacted by sonic booms in the area. Likewise, any transient individuals of the bald eagle moving through the area to other wintering sites located outside of the Nellis Range Complex would not be impacted.

The desert tortoise was recently listed as a threatened species by the USFWS (Federal Register, April 2, 1990). Desert tortoise range throughout Clark County at elevations below 4,000 feet in the Mojave Desert (i.e., the valleys and bajadas of the Southern Range Complex). The USFWS recently completed an investigation of the status and distribution of the tortoise on portions of the DNWR that are not within the Nellis Range Complex. Critical habitats for the Mojave population of the desert tortoise were determined by USFWS (1994c) for four sites in southeastern Nevada. Only the northern section of the Gold Butte-Pakoon Unit (192,300 acres) in Clark County falls within the Nellis Range Complex. Supersonic flight activities would not have an impact on the desert tortoise in the Nellis Range Complex, since supersonic flight does not occur over critical habitat.

Results from the studies conducted on the potential effects of supersonic noise and sonic booms on various fish species (i.e., endangered Devils Hole pupfish) indicate that although short-term effects could potentially occur in some sensitive species, long-term adverse effects to these groups would not occur (SAIC 1991).

- Summary

Threatened and endangered species of plants, fish, reptiles, birds, and mammals identified as potentially occurring within the Nellis Range Complex would not be impacted by supersonic flight operations and sonic booms resulting from the proposed action.

4.1.5 Cultural Resources

To date, over 3,900 sites have been recorded within the Nellis Range Complex, although the entire area has not been intensively surveyed. These property types recorded include lithic scatters, quarries, open

Table 4-1

Military Overflight Restrictions of National Wildlife Refuges (NWR) and Wildlife Management Areas (WMA)

Area	Airspace	Restriction
Pahranagat NWR	Desert MOA	Avoid by 1 NM, overflight restricted to 2,000 feet AGL minimum; supersonic overflight restricted to 5,000 feet AGL to unlimited.
Desert NWR	Desert MOA R-4806E	Overflights restricted to 2,000 feet AGL minimum; supersonic overflight restricted to 5,000 feet AGL to unlimited.
Key Pittman WMA	Desert MOA	Overflight restricted to 2,000 feet AGL minimum; supersonic overflight restricted to 5,000 feet AGL to unlimited.
White River Kirch WMA	Reveille MOA	Overflight restricted to 5,000 feet AGL to unlimited.
Railroad Valley WMA	Desert MOA	Overflight restricted to 2,000 feet AGL minimum; supersonic overflight restricted to 5,000 feet AGL minimum.

Legend: MOA = Military Operations Area
NM = Nautical Mile
AGL = Above Ground Level

Source: SAIC 1991

temporary camps, temporary camps in rock shelters, limited activity localities, petroglyph localities and panels, isolated artifacts, mining camps, boom towns, ranches, and homesteads, as well as possible cliff dwellings, historic pueblos, and adobe-style huts. Also within the boundaries of the Nellis Range Complex is the potential presence of traditional cultural properties, such as sacred areas and places of burial or cremation, that are of cultural importance and significance to the modern Shoshone. These types of resources are protected under the American Indian Religious Freedom Act of 1978, the Native American Graves Protection and Repatriation Act of 1990, and NEPA of 1969, as amended.

Supersonic flights within the Nellis Range Complex would pass over areas with hundreds of historic properties in the form of archeological sites, aboveground structures of rock or rock art of the prehistoric period, and structures related to the historic settlement and development of the region. Although only a limited number of these sites are presently listed on the National Register of Historic Places, numerous others are potentially eligible for listing. Standing structures of either the prehistoric or historic periods and rock art panels are particularly sensitive properties in relation to potential noise impacts.

The potential noise-induced damage to historic properties is not well documented. Previous studies (Battis 1981; Clarkson and Mayes 1972; King et al. 1985; Warren 1972) indicate that historic structures may be less sensitive than popularly thought. A study (Wesler 1977) of a restored plantation house situated approximately 1,500 feet from the centerline of Runway 19L at Washington Dulles International Airport indicated that the induced vibration levels related to Concorde takeoffs were actually less than those induced by touring groups and vacuum cleaning. Furthermore, studies by Goforth and McDonald (1968) and Battis (1981) indicate that sonic boom overpressures of less than 5 psf would result in particle velocities within the safe range for historic structures. Since the noise study of sonic booms related to F-15, F-16, and F-18 aircraft indicated that only 18 booms of 609 recorded exhibited peak overpressures greater than 5 psf, the potential for noise-induced impacts to historic properties is extremely low. Therefore, the proposed action is expected to have no effect on the historic properties within the Nellis Range Complex.

4.1.6 Irretrievable and Irreversible Resource Commitments

The implementation of the proposed action would require the commitment of irretrievable and irreversible resources. The resource commitments for continued supersonic flights would include:

- Tax dollars for the construction of supersonic capable aircraft and continued training and operational funding.
- Fuel, electrical energy, and manpower to support supersonic air combat training.
- Equipment, materials, and supplies for the construction of supersonic aircraft, training, and operation.

Without the implementation of the proposed action, potential negative impacts to the national strength would result since the loss or reduction of air combat capabilities would potentially lessen the strength of national defense. The loss of the irretrievable and irreversible resources is considered reasonable in order to continue supersonic flight in the Nellis Range Complex.

4.1.7 Relationship between Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

The potential for minor short-term disruptions and limited commitment of resources would be necessary to continue supersonic flights in the Nellis Range Complex. The continued training of aircrews for supersonic air combat would contribute significantly to strengthening and/or maintaining the national defense. Long-term benefits to national defense would be derived from the potential short-term minor disruptions. The continuance of supersonic flights would not sacrifice the maintenance and enhancement of the long-term productivity of the environment for the short-term use of the Nellis Range Complex.

4.2 Evaluation of the No Action Alternative

Under the no action alternative, the supersonic flights within the Nellis Range Complex would cease. The Nellis Range Complex would continue to be used for subsonic flights. No change in sortie rates or airspace usage would occur from the selection of this alternative. The existing environmental setting would change slightly from the present condition, since sonic booms would be eliminated. The environmental impacts would not change with the selection of this alternative as compared to the proposed action.

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Appendix A

1993 Air Quality Data
Nellis Range Complex

Table A-1

Number of Sorties at the Nellis Range Complex (Sorties/Year)

Aircraft	Non-Supersonic	Supersonic	Total
A-6	817	0	817
A-10	5,233	0	5,233
F-4	3,308	3,309	6,617
F-5	112	112	224
F-14	734	734	1,468
F-15	7,815	7,816	15,631
F-16	9,534	9,535	19,069
F-18	1,978	1,979	3,957
F-111	1,028	1,028	2,056
Helicopters	824	0	824
Other	9,097	0	9,097
Total	40,480	24,513	64,993

Table A-2

Emission Factors for Aircraft Flying in the Nellis Range Complex

Aircraft	Source	Number Engines	Mode	Fuel Flow (lbs/min)	Total Fuel Flow (lbs/min)	Emissions (lbs/1000 lbs of Fuel)				
						CO	HC	NO_x	SO_2	TSP
A-6E	1	2	Military	122.83	245.66	0.71	0.93	13.02	0.54	0.00
A-10	2	2	Military	42.70	85.40	2.30	0.10	10.00	0.54	0.05
F-4	2	2	Military	163.67	327.33	5.20	0.10	10.60	0.54	0.92
			AB	582.50	1,165.00	4.00	0.01	3.10	0.54	0.15
F-5	2	2	Military	43.83	87.67	29.00	0.80	2.60	0.54	0.018
			AB	138.72	277.43	26.00	0.07	2.00	0.54	0.008
F-14A	1	2	Military	117.50	235.00	1.38	0.77	19.60	0.54	2.98
			Afterburner	796.67	1,593.34	10.79	0.20	4.79	0.54	0.00
F-15	2	2	Military	172.08	344.17	0.90	0.10	27.00	0.54	0.34
			AB	766.83	1,533.67	4.00	0.01	3.10	0.54	0.15
F-16 C/D	2	1	Military	176.33	176.33	0.90	0.10	27.00	0.54	0.34
			AB	766.83	766.83	4.00	0.01	3.10	0.54	0.15
F-18A	1	2	Climbout (IRP)	134.71	269.42	1.05	0.31	25.16	0.54	2.81
			Afterburner	473.28	946.56	23.12	0.13	9.22	0.54	0.00
F-111F	2	2	Military	151.28	302.57	0.70	0.10	28.00	0.54	0.24
			AB	900.00	1,800.00	4.00	0.01	3.10	0.54	0.15
Helicopters	3	2	Takeoff	13.80	27.60	3.00	0.03	7.70	0.54	0.00

1. EPA Procedures for Emissions Inventory Preparation, Vol IV Chapter 5, EPA 450/4-81-026d Updated May 1993.
2. Manual Calculation Methods for Air Pollution Inventories (Fagin 1988).
3. Personal communications with manufacturer.

Table A-3

Emissions from Non-Supersonic Sorties Flying in Nellis Range Complex

Aircraft	Time in Range (minutes)	Number of Aircraft	Fuel Consumed (1000 lbs)	Emissions (lbs)				
				CO	HC	NO_x	SO_2	TSP
A-6	45	817	9,031.7	6,412.5	8,399.5	117,592.6	4,877.1	0.0
A-10	45	5,233	20,110.4	46,254.0	2,011.0	201,104.2	10,859.6	1,005.5
F-4	45	3,308	48,726.8	253,379.6	4,872.7	516,504.5	26,312.5	44,828.7
F-5	45	112	441.8	12,813.4	353.5	1,148.8	238.6	8.0
F-14	45	734	7,762.1	10,711.6	5,976.8	152,136.2	4,191.5	23,130.9
F-15	45	7,815	121,034.8	108,931.3	12,103.5	3,267,939.9	65,358.8	41,151.8
F-16	45	9,534	75,652.3	68,087.1	7,565.2	2,042,611.8	40,852.2	25,721.8
F-18	45	1,978	23,981.1	25,180.1	7,434.1	603,363.8	12,949.8	67,386.8
F-111	45	1,028	13,996.7	9,797.7	1,399.7	391,908.6	7,558.2	3,359.2
Helicopters	45	824	1,023.4	3,070.2	30.7	7,880.2	552.6	0.0
Other	45	9,097	140,889.8	126,800.8	14,089.0	3,804,024.3	76,080.5	47,902.5
Total		40,480	462,650.9	544,637.5	50,146.7	7,302,190.6	173,751.0	206,592.7
Total (Tons/Year)				272.3	25.1	3,651.1	86.9	103.3

Table A-4

Non-Supersonic Mode Emissions from Supersonic Sorties Flying in Nellis Range Complex

Aircraft	Time in Non-Supersonic Mode (minutes)	Number of Aircraft	Fuel Consumed (1000 lbs)	Emissions (lbs)				
				CO	HC	NO_x	SO_2	TSP
A-6	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
A-10	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
F-4	44	3,309	47,297.4	245,946.4	4,729.7	501,352.2	25,540.6	43,513.6
F-5	44	112	1,600.9	46,425.5	1,280.7	4,162.3	864.5	28.8
F-14	43	734	7,368.2	10,168.1	5,673.5	144,416.7	3,978.8	21,957.2
F-15	43	7,816	114,908.1	103,417.3	11,490.8	3,102,519.2	62,050.4	39,068.8
F-16	44	9,535	73,418.4	66,076.6	7,341.8	1,982,297.9	39,646.0	24,962.3
F-18	44	1,979	23,468.9	24,642.3	7,275.4	590,477.6	12,673.2	65,947.6
F-111	44	1,028	13,690.9	9,583.6	1,369.1	383,344.6	7,393.1	3,285.8
Helicopters	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
Other	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
Total		24,513	281,752.8	506,259.8	39,161.1	6,708,570.4	152,146.5	198,764.1
Total (Tons/Year)				253.1	19.6	3,354.3	76.1	99.4

NA - Not Applicable

Table A-5

Supersonic Mode Emissions from Supersonic Sorties Flying in Nellis Range Complex

Aircraft	Time in Supersonic Mode (seconds)	Number of Aircraft	Fuel Consumed (1000 lbs)	Emissions (lbs)				
				CO	HC	NO_x	SO_2	TSP
A-6	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
A-10	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
F-4	80	3,309	5,140.0	20,559.9	51.4	15,933.9	2,775.6	771.0
F-5	80	112	41.4	1,077.2	2.9	82.9	22.4	0.3
F-14	137	734	1,335.2	14,406.7	267.0	6,395.6	721.0	0.0
F-15	137	7,816	27,370.6	109,482.5	273.7	84,849.0	14,780.1	4,105.6
F-16	80	9,535	9,749.0	38,996.0	97.5	30,221.9	5,264.5	1,462.4
F-18	59	1,979	921.0	21,293.8	119.7	8,491.7	497.3	0.0
F-111	59	1,028	1,819.6	7,278.2	18.2	5,640.6	982.6	272.9
Helicopters	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
Other	NA	0	0.0	0.0	0.0	0.0	0.0	0.0
Total		24,513	46,376.8	213,094.4	830.5	151,615.6	25,043.5	6,612.2
Total (Tons/Year)				106.5	0.4	75.8	12.5	3.3

NA - Not Applicable

Table A-6

Total Emissions from Sorties in Nellis Range Complex

Aircraft	Fuel Consumed (1000 lbs)	Emissions (lbs)				
		CO	HC	NO_x	SO_2	TSP
A-6	9,031.7	6,412.5	8,399.5	117,592.6	4,877.1	0.0
A-10	20,110.4	46,254.0	2,011.0	201,104.2	10,859.6	1,005.5
F-4	101,164.2	519,885.8	9,653.8	1,033,790.6	54,628.7	89,113.3
F-5	2,084.1	60,316.0	1,637.1	5,393.9	1,125.4	37.1
F-14	16,465.4	35,286.5	11,917.3	302,948.4	8,891.3	45,088.1
F-15	263,313.6	321,831.2	23,868.0	6,455,308.1	142,189.3	84,326.2
F-16	158,819.7	173,159.7	15,004.6	4,055,131.6	85,762.7	52,146.4
F-18	48,371.0	71,116.2	14,829.2	1,202,333.1	26,120.3	133,334.4
F-111	29,507.2	26,659.6	2,787.0	780,893.8	15,933.9	6,918.0
Helicopters	1,023.4	3,070.2	30.7	7,880.2	552.6	0.0
Other	140,889.8	126,800.8	14,089.0	3,804,024.3	76,080.5	47,902.5
Total	790,780.6	1,390,792.5	104,227.2	17,966,401.0	427,021.5	459,871.5
Total (Tons/Year)		695.4	52.1	8,983.2	213.5	229.9